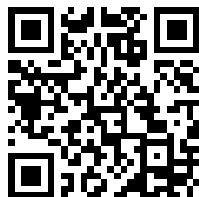

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GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

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48" Alundum Wheel that is Replacing the Grindstone in the Grinding
of Pocket Knives and Shears

GRITS AND GRINDS

Vol. IV

May 1912

No. 1

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Natural Grindstone vs. Artificial Wheel

With the Introduction of Artificial Grinding Wheels Comes Safer and Healthier Working Conditions

Frightful Mortality Caused by Grindstone Dust—Problem Solved by Modern Grinding Wheels—Why Modern Conditions are not Conducive to Ill Health

By George N. Jeppson.

Vocational disease, as well as its prevention, is receiving the attention of the industrial world to a greater degree than ever before, both on the part of the worker and the employer of labor. Both sides realize that life can be conserved, and that carelessness in respect to safety appliances and conditions that menace the health and life of men society will not tolerate. We note that so-called Employers' Liability Acts are being passed in every state, and that the hazard of a business will be part of the cost of the goods manufactured which, in theory, will be paid for by the consumer.

Accident prevention devices will be used to bring down this hazard so as to make this cost to the business as low as possible.

It is only a question of time when occupational diseases, such as are prevalent in the chemical industries, stone quarries and other dust-producing occupations will, by legislative act, be made a part of the cost of doing business. I have given some attention to the great mortality among the workers on the silicious grind-

stone, or the natural stone so commonly used in the cutlery industries.

Tuberculosis has become a very familiar word in our vocabulary, due to the great crusade against it in the last decade, and now the people of every land recognize the conditions which are most conducive to this disease and realize that it is contagious and that a careful treatment is required if the patient would be cured. The mortality of this disease among grinders on the natural stone is frightful. "Grinders' rot," "grinders' asthma" and "grinders' consumption" are very familiar terms among the industries using grindstones.

The following statistics from the recently closed International Hygiene Exhibition in Dresden gave the mortality in the grinding trades of Sheffield, England, during the years 1901 to 1909:

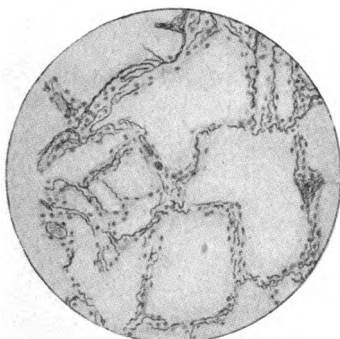
It will be noted that the death rate among grinders due to phthisis or tuberculosis and respiratory diseases runs as high as 35% in some trades and that the average for all males in this district runs in these diseases about 6%.

Trade and Branch	Number of Male Workers, 18 Years and Over	No. of Grindstones and Glazers	DEATHS					
			ALL CAUSES		PHTHISIS		RESPIRATORY DISEASES	
			Number	Rate per Annum per 1,000 Living	Number	Rate per Annum per 1,000 Living	Number	Rate per Annum per 1,000 Living
Grinding	3,941	6,298	1,077	30.4	534	15.1	192	5.4
Forks and steels	96	176	32	37.0	17	19.7	4	4.6
Augers, etc.	54	95	11	22.6	9	18.5	1	2.1
Surgical instruments	28	55	9	35.7	5	19.8	3	11.9
Scissors	194	433	81	46.4	45	25.8	19	10.9
Razors	413	650	123	33.1	52	14.0	22	5.9
Edge tools	279	567	70	27.9	43	17.1	8	3.2
Knives, table and spring	1,518	2,516	402	29.4	193	14.1	72	5.6
Sheep shears	143	161	45	35.0	31	24.1	5	3.9
Agricultural & mining imp.	156	203	1	0.7				
Hammers, vises, anvils, etc.	53	59	6	12.6	2	4.2	1	2.1
Saws	216	416	53	27.3	17	8.7	7	3.6
Scythes and sickles	40	57	12	33.3	8	22.2	3	8.3
Files and rasps	378	404	105	30.9	57	16.8	18	5.3
Miscellaneous	373	506	127	37.8	55	16.4	29	8.6
Cutlery	3,889		1,025	29.3	203	5.8	243	6.9
All males (20 and over).....	124,000		18,478	16.6	3,036	2.7	3,801	3.4

City of Sheffield—Mortality in the Grinding Trade and Its Branches, and in the Cutlery Trade During Nine Years, 1901 to 1909, from all Causes, and from Phthisis and Diseases of the Respiratory System

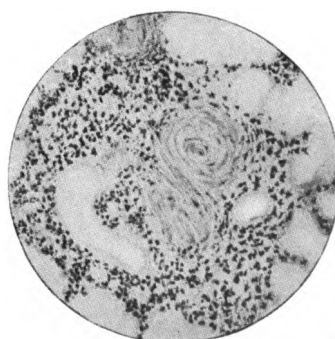
All operatives on these stones should know the danger to which they are exposed. The symptoms of this lung disease are as follows: the onset and course is a slow one; bronchitis with a cough and expectoration, often with particles of dust, is the commencement; the general

Dr. Duncan Burgess, Senior Physician to the Sheffield Royal Hospital, asserts and has proved by microscopic study of the lungs of grinders that it is the dust of the grindstone that is the cause of these diseases, the chips of steel ground off playing a minor rôle.



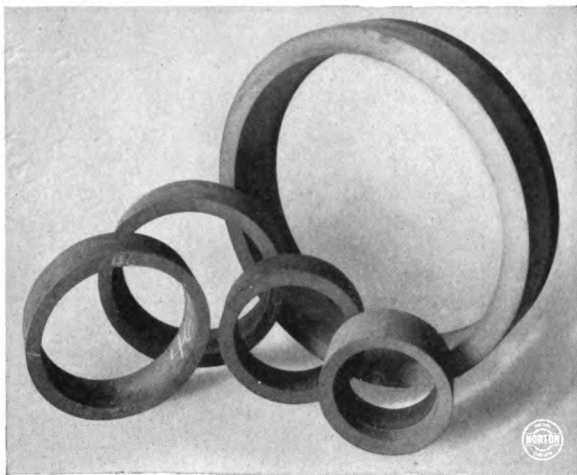
The Human Lung in Health.

health gives away; appetite, color and flesh fail; difficulty of breathing follows and finally, if the disease is not checked, general destruction of the lungs takes place and death ensues.



Grinder's Lung Affected by Grindstone Dust

The question arises as to what can be done to better conditions in these trades. If grindstones are to be used, the ventilation of the workroom should be carried out in as scientific a manner as possible



Alundum Wheels Replacing Grindstones in the Grinding of Table Cutlery, Skates, etc.

and the dust from dry grinding, racing or truing of the new stone should be exhausted by fans. Where wet grinding is used, the workroom should be well-heated and ventilated. Guards on wheels should be so arranged that the grinder can be kept as dry as possible. His position at his work should not interfere with the free expansion of his lungs.

In spite of all these precautions, we find that in the best grinding rooms of the country, where grindstones are used, the labor problem is a difficult one, mainly because of the prevalence of disease and sickness.

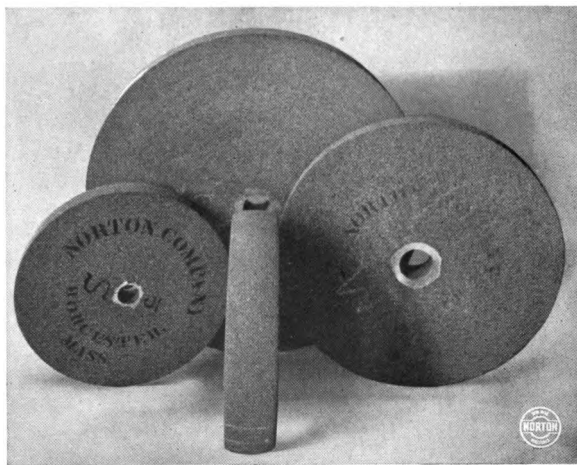
It is interesting to know what is being done to displace the natural grindstone. Mr. H. K. Dodge's article in this issue of "Grits and Grinds" gives an idea of what is being done in the cutlery trade of the United States with

artificial stones made of Alundum.

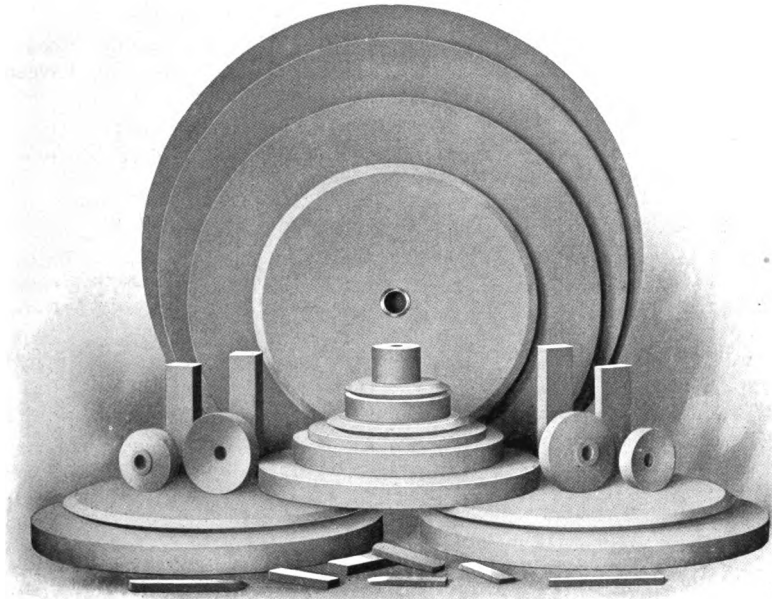
Hemming Bros., New Haven, Conn., have solved the problem of grinding table cutlery with artificial wheels. The surfacing of steel plows in the United States is now done on artificial Alundum wheels. Skates, axes and hatchets are being ground successfully on these wheels. In fact, it is the opinion of all who are in a position to know that all work done on grindstones can be done on artificial wheels made of modern electric furnace abrasives.

The skeptic asks why the dust from the modern grinding wheel is not as dangerous to the health as that from the grindstone.

First: The life of the grinding wheel is from 11 to 15 times that of the natural stone. It comes to the user in truth so



Alundum Wheels Replacing Grindstones in the Grinding of Axes and Plow Shares.



**Alundum Stones that are Replacing Natural Stones
in the Glass Industry**

that it need not be raced into shape. It is at once proven that we have a much less volume of dust to handle than if we use a natural wheel of the same dimensions.

Second: The application of the modern wheel, permits the use of a relatively small wheel, consequently it is more practical to give the operator better protection by dust exhausters and water hoods.

Third: Dust from all abrasives from which these modern wheels are made does not affect the lungs and does not cause bronchial troubles. A most thorough medical examination of more than 600 employees of Norton Company revealed only four cases of tuberculosis. The history of these showed that the disease was contracted outside the works and among men who had been in the employ

of the Company but a comparatively short time. This percentage is remarkably low and compares favorably with that of the most healthful community. Many of these Norton men have been in the employ of the Company from twenty to twenty-five years.

In conclusion, it is fair, then, to note that an advance has been made towards stopping the death toll of a trade, the mention of which has made those familiar with its statistics shudder, and it can be truly said that the grinder of the future in the well-heated and ventilated work-room and with the modern grinding wheel of to-day will be as far from occupational disease as the farmer who tills the soil, or any other worker in the most healthful environment.

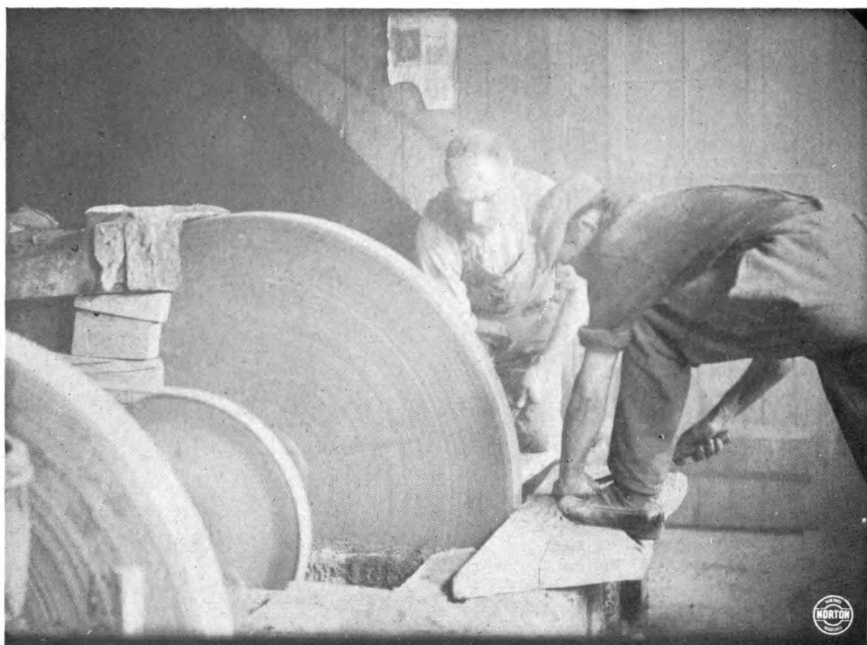
Replacement of Grindstones in the Grinding of Cutlery

By H. K. Dodge

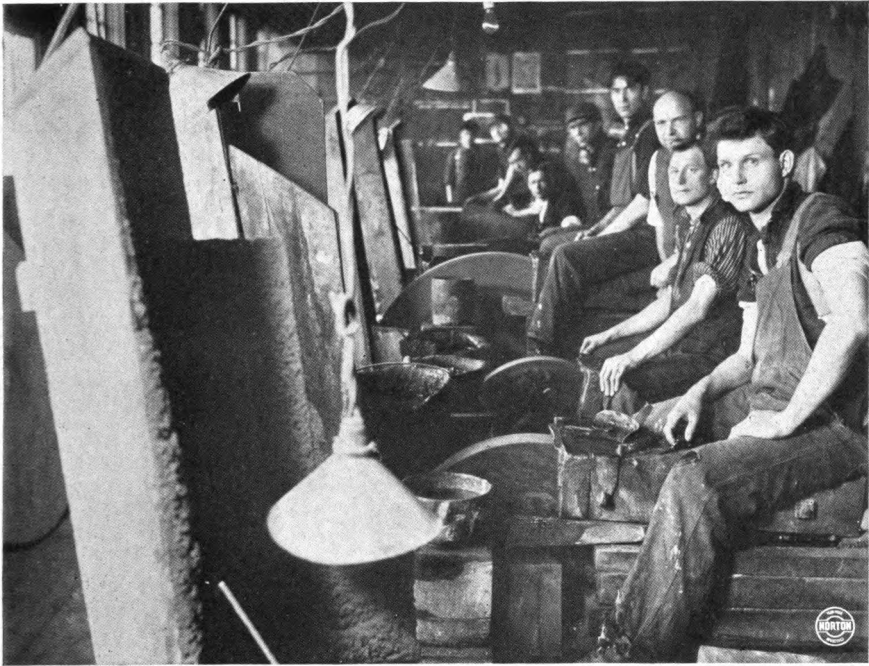
That the Alundum wheel has proven successful in the grinding of cutlery—pocket knives, table knives, shears, etc.,—is evident from the fact that while it was only recently introduced into this field, there are now enough Alundum wheels in use to replace nearly 5,000 grindstones of equal size. One Alundum wheel will do the work of fifteen (15) grindstones. If all of these stones were 48 x 4" this would mean a saving in handling of something like 2,500,000 lbs. of material, or fifty 25-ton carloads. It is only a question of time when manufactured wheels will have completely replaced natural grindstones in cutlery grinding.

Grinding Pocket Knives

When the first attempts were made to introduce the large 48" Alundum wheels into the plants of the pocket knife manufacturers, the salesman's suggestion was usually met with a reply something like the following: "There is no use of you spending your money and taking up our time in mounting and testing, as it is impossible for any grinding wheel manufacturer to make a wheel that will not burn or draw the temper." After they had been convinced that a wheel could be manufactured that would not draw the temper the question of price was at first another handicap.



Racing a Sandstone. The Dust Causes Other Employers to Leave the Room During this Operation.



Alundum Wheels Used in the Grinding Room of Schrade Cutlery Co., Walden, N. Y.

However, it needed but a demonstration to show that the Alundum wheel was far superior to the grindstone in both cutting and lasting qualities and far more economical to use.

The next stumbling block in their introduction was the labor union. In the first large shop where an introduction of the Alundum wheel was secured, it was opposed from the start by the workmen, owing chiefly to a fear of a cut in wages on account of its adoption. Their fears, however, were finally quieted on assurance that there would be no cut in the wage scale, and from that time on, Alundum wheels were preferred by practically every workman who ever used one on this line of work.

The accompanying picture shows a modern grinding room in a cutlery plant where every man is using an Alundum wheel. This concern was the first manufacturer to introduce Alundum wheels

and the remarkable success is due in a large measure to the interest they took in it, and to the experiments conducted in their grinding room.

Mounting and Truing Grindstones

The hanging and truing of grindstones is a big undertaking. It requires from one and a half hours to a whole day to hang, turn and race a sandstone, the variation in time being due to the varied texture of the natural stones. They are received at the grinding room roughly turned, with a square hole in the center, and in hanging, wood blocks are placed between spindle and hole to center the stone. The flanges are then adjusted and nuts tightened, wood collars being used between metal flange and stone. Practically no attention was ever given to having flanges concave or spindle turned round to a standard size.

As will be noted by the illustration on page 6 it requires two men to turn down a sandstone, and all other employees in the same room are compelled to leave to avoid breathing the dirt and dust which fills the air during this operation. It is not unusual for a workman to ask for two or three days off after turning and racing a sandstone "to wash down the dust." Attention is called to the condition of the atmosphere in the racing illustration during the operation of turning.

The tools used for truing are very crude. Ordinary iron pipes for turning or roughly truing and racing steels for the final truing.

With the grindstone there is considerable loss in time, loss in production because of the necessity of frequent stops "to open up" when glazed or loaded, or to use the hack hammer when the stone is hard or contains a hard spot.

As the life of a sandstone is from three to six weeks, it will readily be seen that the time consumed in mounting and truing means a big loss in production.

Mounting and Truing Alundum Wheels

To mount and true one of the large 48" Alundum wheels, requires about fifteen minutes. It does not interfere in any way with the other operators in the room.

The diamond tool is apparently the most successful in truing an Alundum wheel although in some places, they depend on a dresser to do this work, the Huntington type being usually employed. After the dresser has been used a Crystolon brick or the racing iron is used for removing ridges or smoothing the grinding surface.

Alundum wheels should never be hacked. They should be mounted on



Using Alundum Wheels in Place of Grindstones in Grinding Room
of New York Knife Co., Walden, N. Y.



Using Alundum Wheels for Grinding Shears. German Method in the Foreground; English Method in the Background. Courtesy of J. Wiss & Sons, Newark, N. J.

spindles perfectly round, and turned and finished to standard size. One of the flanges should be made fast or shrunk on spindle, the other flange loose.

Use of Water

Alundum wheels are run wet, the same as grindstones, the trough being filled each morning up to a point that will allow about three-quarters of an inch of the wheel to be run in water. They must not be allowed to stand over night in water; the water should be drained out of the trough each night.

Advantages of Alundum Wheels over Grindstones

The average life of the grindstone is from three to five weeks; of the Alundum wheel from twelve to fifteen months. Users claim that one Alundum wheel will outwear from eleven to sixteen grindstones. The corners of the grindstones soon wear away, giving an inferior grade of work. This is very noticeable when comparing the work of the grindstone with that of the Alundum wheel.

Owing to the operations employed in the use of grindstones that cause a loss

of time, the Alundum wheel will grind fully 20 per cent. more work. It is an admitted fact that in shops where Alundum wheels have been installed, 20 to 35 per cent. more work is done every day than was formerly done on the grindstones.

From actual records of work ground, the time the wheels will last and the cost taken into consideration, Alundum wheels are far more economical than the grindstones.

The one great argument that stands out in favor of the Alundum wheel is that of healthy and sanitary working conditions. Until the introduction of the Alundum wheel for this class of work, it seemed that the tremendous loss of life due to unhealthy and unsanitary conditions under which the men were obliged to work on the grindstones was unavoidable. The sentiment of the workmen is found in the following sentence which is an extract from a letter written by a man who signs himself "A Pocket Knife Grinder." "I have worked on the Alundum stones for years, and they are the best stones I have ever worked on; * * * but I think the Alundum stones are the stones for the grinder because they do not make any dust. I will never work on another sandstone if I can avoid it."

The introduction of Alundum wheels in this field has brought a remarkable change in healthy conditions which is not only appreciated by every operator but by employers.

Automatic Machines

The introduction of Alundum wheels is not the only important step in advance in the cutlery industry, as in recent years there have been a number of successful automatic machines introduced for various operations. Among these are: Automatic Side Grinding Machines for pocket knife blades, Semi-automatic Wet Grinder for shaping pocket knife blades, Shaping Machine for shaping the pointed end of the blade and a Swaging Machine used for grinding the swage, both cut in and drawn, which is the narrow bevel on the back edge.

A line of Automatic Machines for pocket knife work are manufactured by Hemming Brothers, New Haven, Conn., and Thomas R. Moore, Walden, New York.

Alundum wheels are the most successful wheels used on the Automatic Machines. On Hemming machines, Elastic wheels give the best results, while the Vitrified is the most successful on Moore machines.

Grinding Table Knives

The replacement of grindstones on table knife work was brought about through the installation of automatic wet grinding machines. The automatic grinding machines and the use of Alundum wheels have reduced the cost of production considerably, being in some instances as great as five to one.

Grinding Shears

Many operations formerly done on grindstones are now being done on Alundum wheels. However, it is almost a certainty that shear manufacturers will, within a reasonable time, install grinding machines that will grind a greater part of their work now being done on grindstones.

On page nine we show two methods in use to-day in grinding shears. In the foreground is shown what is known as the "German" method; in the background is shown the "English" method. Operators who have become accustomed to Alundum wheels for this work and the foremen of grinding departments where Alundum wheels have superseded the grindstone are of one opinion which is that they will never go back to the use of the grindstone to grind this class of work.

Automatic Machines for table knife work are furnished by Hemming Brothers, New Haven, Conn., and A. F. Bannister & Company, Newark, N. J. The machines used by the shear manufacturers are made by Hemming Brothers.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

"Making Worm Gears in Great Britain," by I. W. Chubb. Bringing out the methods of cutting the wheel using roughing and finishing hobs. The worms are ground and polished after hardening. American Machinist, May 9th, 1912, pages 739-742.

"Making Needles for Talking Machines," by Fred H. Colvin. An interesting article on the making of these needles, showing the important part taken by the grinding wheel in their manufacture. American Machinist, May 9th, 1912, pages 749-750.

"A Dead Center Grinder," by Gus Haessler. Description of a dead center grinder used in the manufacture of watches on a large scale. American Machinist, May 16th, 1912, page 797.

Automatic Surface Grinder. The Northampton Emery Wheel Co., Leeds, Mass., is building a new automatic surface grinder. It is of a heavy construction and may be obtained in three different sizes. A description may be found in American Machinist, May 16th, 1912, page 811.

"Grinding Five Parallel Bearings." An interesting problem and its solution which arose at the Rivett Lathe Mfg. Co., Brighton, Mass. American Machinist, May 23, 1912, page 837.

A Water Tool Grinder. The Northampton Emery Wheel Co., Leeds, Mass., are building machines which will carry wheels 16", 20" and 24" diameter. A

cut with description of machines may be found in American Machinist, May 23, 1912, page 852.

A Floating Work-Holder for the Disk Grinder. An article, cut and drawings illustrating how The Pacific Electric Heating Co., Ontario, Cal., use a floating work-holder in grinding the top of electric sad-iron castings on a Besly grinder. American Machinist, May 23, 1912, page 847.

A new grinding dog, which is considered an improvement over the old type, has recently been placed on the market by Thomas S. Barter, Worcester, Mass. It is made in four sizes, $1\frac{1}{2}"$, $2\frac{1}{2}"$, 4" and 7". The chief advantage is in the reversible jaw which enables one dog, on the smaller sizes of work, to handle the work usually requiring two dogs. In the larger work, one dog is all that is required to handle a variety of work, the reversible jaw taking the smaller sizes. The dog is easily adjusted, the side screws being held in place by check nuts which keep the screws from changing the diameter of the dog, after being set. The three larger sizes are brass lined. The binder screw has a brass tip held in place by a pin which passes through the binder screw; by this method of holding the brass there is no twisting of the brass on the work. The driving pin will drive from the projection on the reversible jaw which gives the operator a chance to revolve the work more than a half turn for calipering, to see if the work is round.

NEW PHILADELPHIA AGENCY.

Powell, Clouds & Co., 602 Arch St., have been appointed exclusive agents for Norton Grinding Wheels (both Alundum and Crystolon) in the city of Philadelphia. They will carry a stock of Norton products sufficient to meet the requirements of the trade in that territory.

This firm has a commendable reputation and we can assure all users of Norton products in the Philadelphia territory of not only prompt service but pleasant business relations with our new agents.

VISIT OF AMERICAN ELECTRO-CHEMICAL SOCIETY

Nearly one hundred members of the American Electrochemical Society visited the works of Norton Company, Norton Grinding Co. and American Steel & Wire Co. on April 18th, while the society was holding its annual meeting in Boston. The excursion was run from Boston to Worcester for the express purpose of a trip through the Norton works and to witness a demonstration of the Heroult 15-Ton Electric Furnace at the South Works of American Steel & Wire Co.

Norton Products

Alundum Grinding Wheels

Crystolon Grinding Wheels

Alundum Grain for Polishing

Crystolon Grain for Polishing

India Oil Stones

Crystolon Sharpening Stones

Glass Cutting Wheels

Razor Hones

Scythe Stones

Norton Alundum Refractories

Norton Valve Grinding

Compound

Rubbing Bricks and Stones

Grinding Wheel Dressers

Grinding Machinery

Norton Company, Worcester, Mass.

Alundum Plant, Niagara Falls, N. Y.

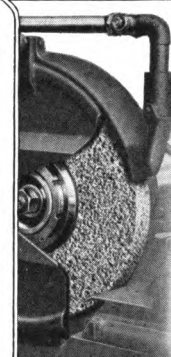
Crystolon Plant, Chippawa, Canada

New York Store, 151 Chambers Street

Chicago Store, 11 N. Jefferson Street



GRITS and GRINDS

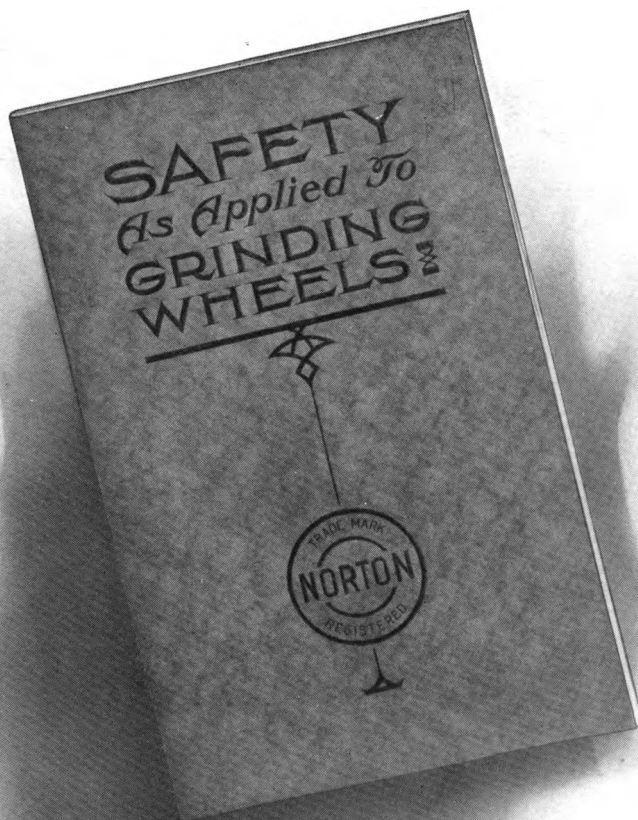


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JUNE

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GRITS AND GRINDS

Vol. IV

June, 1912

No. 2

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Safety as Applied to Grinding Wheels

The cause of accident prevention has been effectively served by Norton Company's book of the above title. It has contributed so largely to the welfare of the grinder that a second and more complete edition has been published.

Safety of the grinder depends largely upon thoughtful and ingenious designing in the direction of making the grinding machine with its accessories as near perfect as possible, and providing against thoughtless or careless manipulation to a considerable degree. In this book we illustrate many types of hoods or guards, and their application to machines of various types, several practical applications of dust exhaust systems, numerous devices such as shields, spark brushes, and goggles for eye protection, devices for limiting speed, for preventing the use of wheels above a certain diameter, and various types of flanges. Its many concise statements of facts in regard to the proper and improper methods of mounting and using wheels will be of assistance to both foreman and superintendent.

Safety as Applied to Grinding Wheels will be mailed to any one on request, free of charge.

Broad Application of Safety Principles

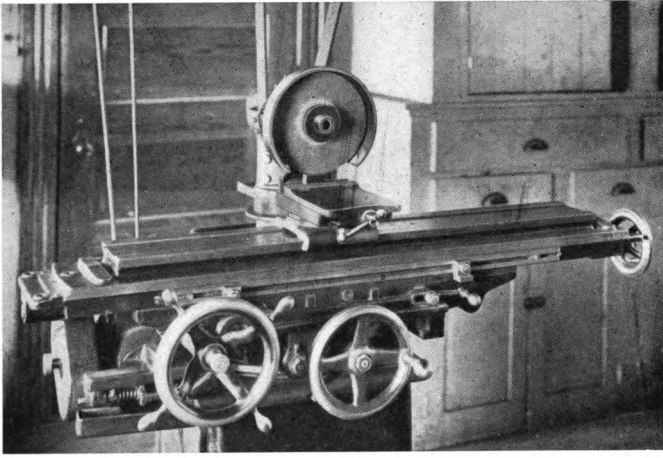
Accident prevention and safety consist of more than simply mechanical safeguards protecting the operator as effectively as possible from physical violence, and extend into the field of health

hygiene calculated to protect the worker from the more insidious dangers against which mere mechanical protection can only partially safeguard and which undermine the physical and mental well-being of the operator.

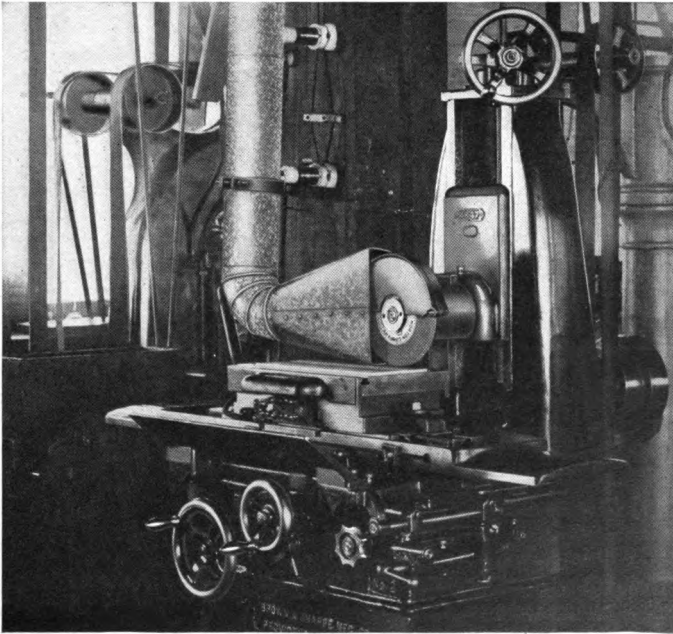
A well-developed plan of safeguarding workmen must carry with it an extensive medical department with an attending physician who watches carefully over each individual worker maintaining records of his physical condition, alleviating his suffering during illnesses, oftentimes nipping such in their incipient stages, and, what is of greatest importance to both operator and employer, advising with the task maker as to any worker's physical defects so that he may apply his efforts in a manner calculated to bring the least possible strain to bear on such defective organs. Proper sanitation of washrooms and retiring or rest rooms are also an important function of the medical department.

The effect of thus providing for the welfare of operators by bringing the ingenuity of the engineering and medical professions effectively to bear is as remarkable as it is gratifying.

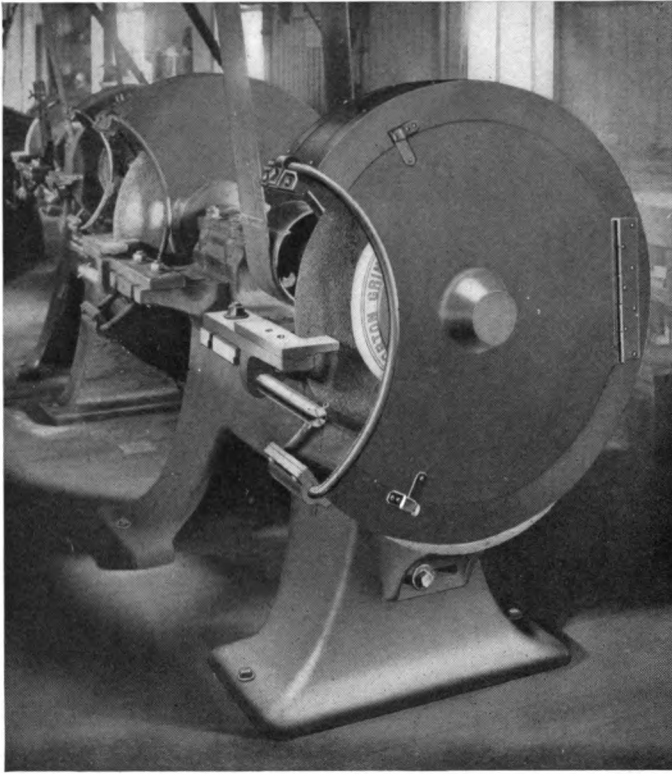
As to mechanical safety contrivances, this book points out the many ways in which such can and should be applied to a certain class of machines, whether manufactured as a means to accomplish the production of other articles or whether manufactured for the market. Protection should go farther—all danger points



Adjustable Hood which can be Adjusted to Permit Work on any Part of the Wheel's Face.



The above illustration shows how a surface grinding machine is connected with a dust exhaust system in the plant of The Yale & Towne Mfg. Co., Stamford, Conn. It also shows a practical application of protection hood on this type of machine.



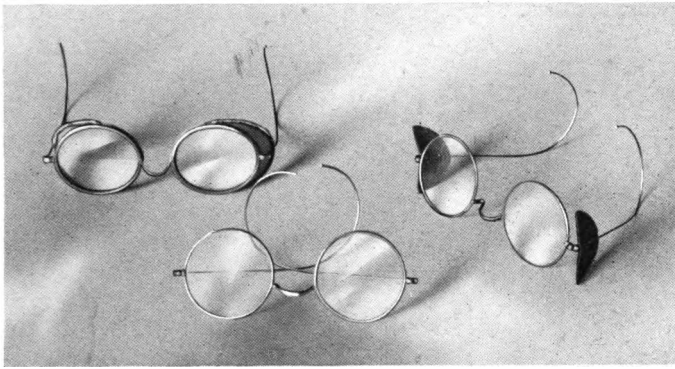
Combination Dust Hood and Protection Hood

such as power transmission apparatus, electrical connections, elevator shafts and stair wells should be guarded, while cleanliness and general tidiness are equally potent factors, and should be rigidly enforced.

The Norton efforts in promoting safety were first applied in the development of protection hoods that would protect in case of grinding wheel breakages. Further development of the fundamental principles was a process of evolution until not only safety hoods but countless other protection devices quite naturally grew out of the early efforts when once the far-reaching importance of the underlying principles was realized. Since the application of the safety hood to grinding machines and the general protection throughout its own

works, not a single serious accident is to be recorded; in itself a record worthy of careful consideration.

The medical department, added a year ago, has already performed remarkable service. Sickness is less prevalent and many of the cases that do arise are so promptly taken in hand that the development of the malady is stifled in its early stages, never attaining the proportions of a serious illness. Thus the workmen and employer are benefited alike, the former not losing time and earning power while the latter has the benefit of a less disrupted organization. A feeling of confidence prevails; the men are instructed in the handling of emergency cases, promptly relieving a co-worker of much discomfort and pain.



While the wide application of protection devices has reduced even the most hazardous operation to one of almost complete harmlessness, the medical department, by the ever watchful guardianship exercised over the physical well-being of 1,000 men, has reduced time loss due to illness by 50% and raised the general tone of the organization by many degrees.

Eye Protection

Glasses or goggles should be worn to protect the grinding machine operator's eyes.

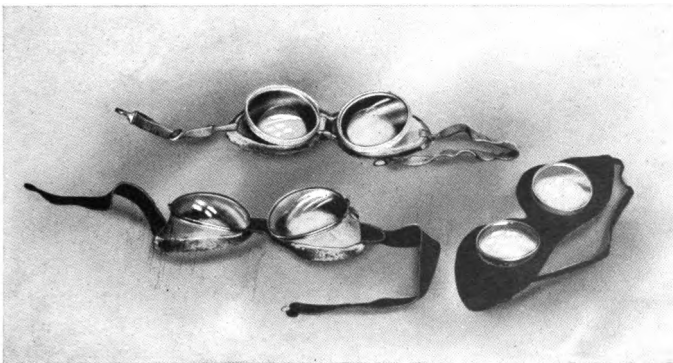
Various types of goggles are in use. The type which protects from the side as well as from the front is recommended. A simple metal frame surrounding large

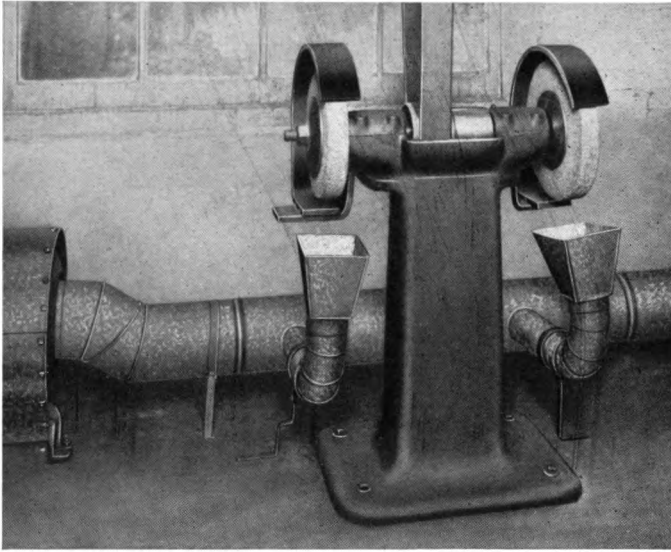
pieces of relatively thick, clear glass and having on the sides a device consisting of a wire web hung on hinges, so that the glasses may be folded up, have proven very satisfactory.

Types of goggles, such as illustrated here, having leather masks and cups, and lined with satin or some other soft material, afford good protection to the eyes, but are objectionable in warm weather, as they do not allow for proper ventilation.

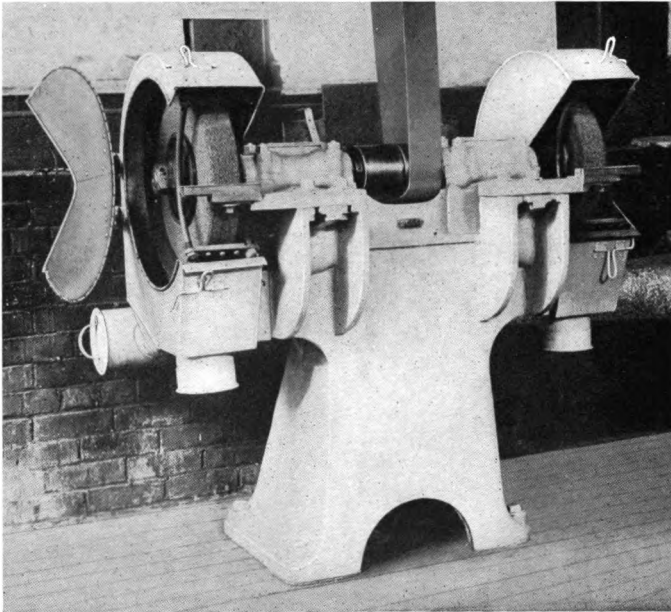
A very common practice is to take two pieces of leather and put on the frames of a pair of ordinary glasses for side protection.

The goggles should be made as light as possible as workmen sometimes object to their use on account of weight.

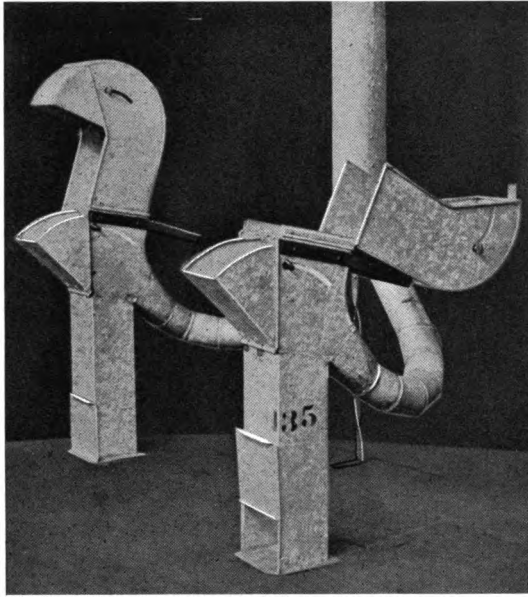




Here is illustrated a grinding wheel stand connected with a dust system in the plant of The Addressograph Co., Chicago, Ill.



A stand equipped with an efficient type of hood and connected with a good dust system in the plant of The Yale & Towne Mfg. Co., Stamford, Conn. Above this machine is a notice which gives the number of machine, speed at which it runs and the largest size wheel that is allowed to be put on the spindle.



An Adjustable Hood for Use in Connection with Dust Exhausting System. Courtesy of Kirk & Blum, Cincinnati, Ohio

Abstracts from Current Articles Pertaining to Grinding

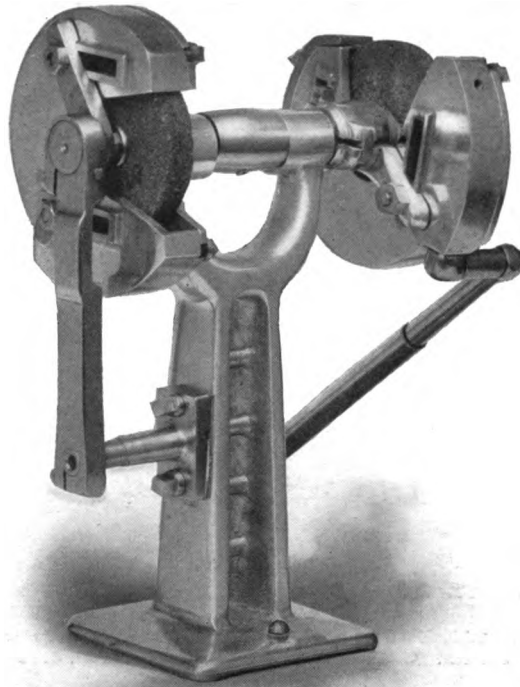
Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

"Grinding Wheel Efficiency," by Revere Chapell. In which the writer shows how various conditions affect the wheels; the effect of the machine on wheels and some difficulties to overcome. The last item covers burning of work, loading and glazing of wheels, soft spots and wheels out of balance. *American Machinist*—May 30, 1912, pages 871-2.

Vertical Grinding Planer with Movable Head. The Springfield Mfg. Co., Bridgeport, Conn., have recently designed a new surface grinder capable of grinding stock 30" wide and 7' long. *American Machinist*—May 30, 1912, page 889.

A Special Roll Grinding Machine. The Springfield Mfg. Co., Bridgeport, Conn., have brought out the above machine for grinding concave rolls and also internal work. Cut with description in *Iron Age*—May 30, 1912, page 1342 H.

Combined Grinding and Fluting Machine. G. Swift & Sons, Halifax, are making a combination grinding and fluting machine. The European edition of *American Machinist* for May 18, 1912, page 98 E, has a description and cut of this machine.



**Adjustable Hoods—Courtesy of Emery Wheel Safety Guard Co.
Milwaukee, Wis.**

"The Difference in Grinding Time and Why," by J. R. Godfrey. A short exposition to show that before deciding upon any method of machine work it is necessary that all conditions be carefully considered and total costs counted before deciding the better way for a particular operation. *American Machinist*, European edition, May 18, 1912, page 659.

A New Grinding Machine. The Bryant Chucking Grinder Company, Springfield, Vt., are bringing out a line of one- and two-spindle chucking grinding machines for duplicate work. Several cuts and drawings illustrate the article, giving a very comprehensive idea of the machines. *Iron Age*—May 30, 1912, pages 1342 B and C.

Ball Bearing Polishing Stand. The Gardner Machine Co., Beloit, Wis., have designed a new ball bearing polishing stand. Description and cut can be found in *Iron Age*, May 30, 1912, page 1342 G.

Dust Systems

Grinding rooms should not only be well ventilated and well lighted but the machines should be attached to a dust system. Besides protection to the workmen, the dust system prevents wear and tear on machinery and belts.

There are many efficient and practical types of dust systems.

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

JULY

1912



**Government Projectiles are Ground on Norton Grinding Machines
with Norton Alundum Wheels**

GRITS AND GRINDS

Vol. IV

July, 1912

No. 3

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Chattering in Cylindrical Grinding

By Charles H. Norton

Recent developments seem to warrant a re-telling of the story of chattering when using cylindrical grinding machines. We have told this story before many times, but it appears that many of the people connected with our organization are still unfamiliar with the history.

Away back in the days of Joseph R. Brown, the originator of the Universal Grinding Machine, it was the custom, when grinding such articles as needle bars, to place a flat spring or wire spring with the end covered with leather, so that the leather would bear upon the revolving needle bar. This flat spring pressing upon the bar was sufficient to keep the needle bar from chattering while it was being ground.

It was recognized at that time that these chatter marks were caused by the vibration of the work itself, and not by the vibration of any part of the machine in which it was ground; and the means taken for stopping this vibration proving to be successful, also proved that the first proposition—that is, that the chatter-marks were caused by the vibration of the work itself—was true.

To-day we have this same problem in nearly all work that is ground. Nearly all work that is ground will vibrate under the cut of the wheel, regardless of the machine in which it is ground. It has come to be the habit to-day to charge all such chatter-marks and imperfections to the grinding machine, when as a matter of fact probably not one per cent. of them

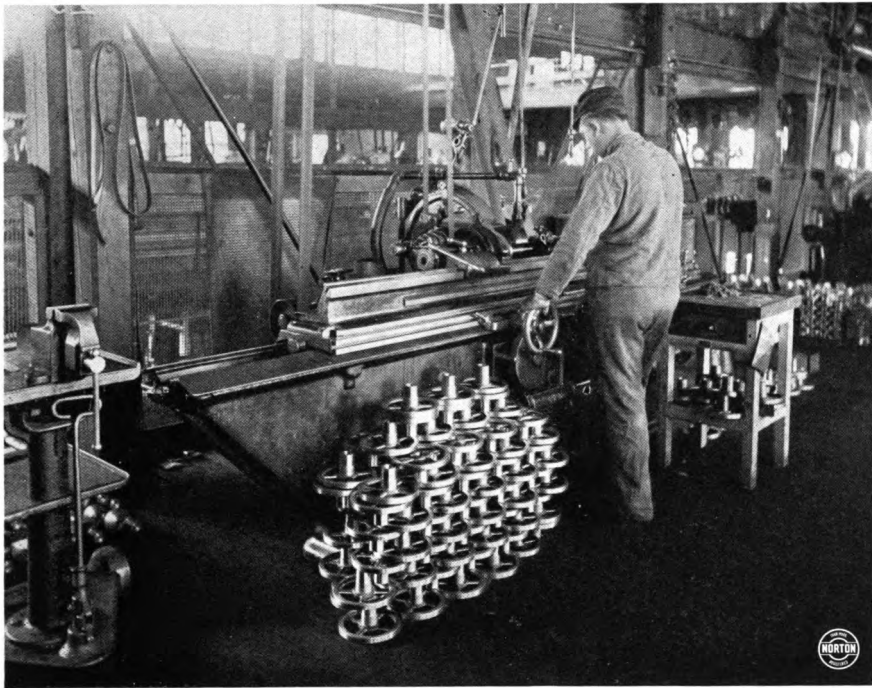
are caused in any way by the grinding machine, but rather by misunderstanding on the part of the operator and a lack of knowledge about how to operate the grinding machine he is using.

With all types of grinding machines where production is small and finish is the principal item, the cut is so light that in many cases (and possibly nearly all) there is no chattering; but in all classes of grinding machines where the production is large, the very fact that the production is larger will cause the work to vibrate unless some means is taken to offset this extra work and vibration, by using proper steady-rests and a proper speed of the work.

It is perfectly feasible to grind any and all work round and smooth, and produce a surface so accurate that no chatter-marks can be seen, even when the work is rubbed in a hole, provided the correct speed of revolution is selected and proper steady-rests are used.

There seems to be a disposition on the part of many of our operators and those of our customers to avoid selecting the proper speed, thinking that a slower work speed will reduce production. As a matter of fact a slower speed will increase production if properly understood and the wheel used in the right way.

There never is a case where steady-rests are not an advantage, no matter how heavy the piece of work, no matter how short the piece of work, no matter what the shape of the piece may be; a steady-



**Index Wheels with Spokes and Long Hubs, Drop-forged in One Piece—
Used on Norton Plain Machines**

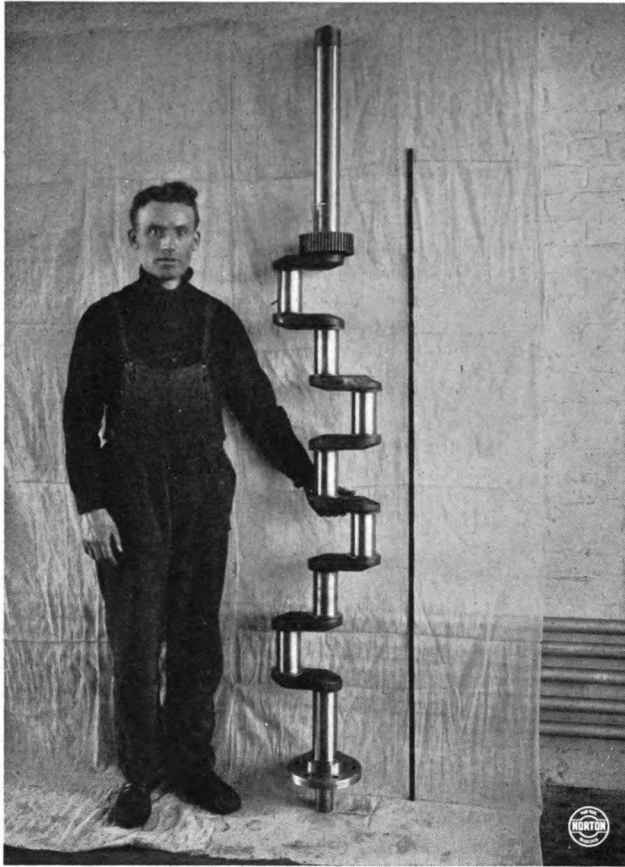
rest is always an advantage and will increase the production, and if properly used in connection with the proper speed will avoid all suggestion of chatters and give perfect work.

While there may be such a thing as imperfect gearing in machines where the work is driven with gears, and this imperfect gearing may cause marks in the work, it is usually the case that the gearing is correct and that the marks are caused by the vibration of the work itself, independent of anything in connection with this gearing or with the machine. It is probable, also, that the driving dog, in many cases, will set up vibrations, due to the fact that there is torsion in this driving dog. This can be taken care of by proper steady-rests, the friction of which will continue to keep the torsion wound up and prevent vibration.

The speed of revolution of the work, also, can be changed, as before stated, so

as to offset the vibration caused by the cutting wheel. While steady-rests will prevent vibration at any speed with some pieces of work, with others it is necessary to change the speed in order to break up the uniformity of vibration between the rubbing of the wheel and the revolution of the piece of work. To illustrate, certain test pieces have been ground, showing that with a certain speed of revolution there were seven vibrations to the inch of circumference; with a change of speed of work the vibration was increased to ten; with still another change of speed of work the vibration was increased to thirty per inch of circumference.

Let us repeat that, whether the work is being revolved direct by belt or by gearing, or by other means, if the work itself vibrates while the wheel is rubbing upon it, there will be vibrations. Sometimes they will be visible to the eye before lapping; at other times they will be so small



Crankshaft for Gasoline Traction Engine—One of the Largest Ever Ground on a Norton Machine. It was Put in Running Balance by Means of a Norton Running Balance Machine. The Six-foot Rule Shows the Length

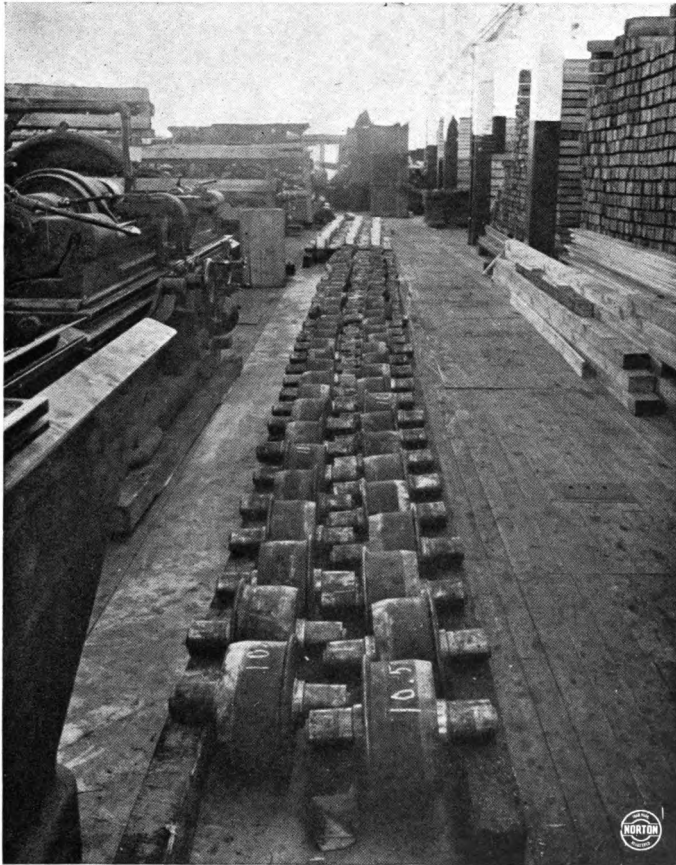
as to be invisible until the work is lapped. In all cases let us repeat that the work itself will vibrate when being ground, no matter what machine it is ground in, and no matter what the piece of work may be; and all operators must recognize this fact, no matter whose machine they are using—whether it be manufactured by the Norton Grinding Company or by others. The best way to overcome it, and the only way, is to use proper steady-rests, and the stiffer these steady-rests are the more rapid work can be done and not cause chatters.

Speed of revolution is important and cannot be ignored, no matter what the design of the machine, and no matter what the method of driving the work; the proper speed of revolution and the proper wheel must be selected to prevent these imperfections in grinding, and whoever ignores this fact will simply have his trouble for his pains. It is better for us all to recognize these physical laws and obey them than to attempt to avoid them and try and get something for nothing, which is always impossible.

Let us repeat, increased production in-

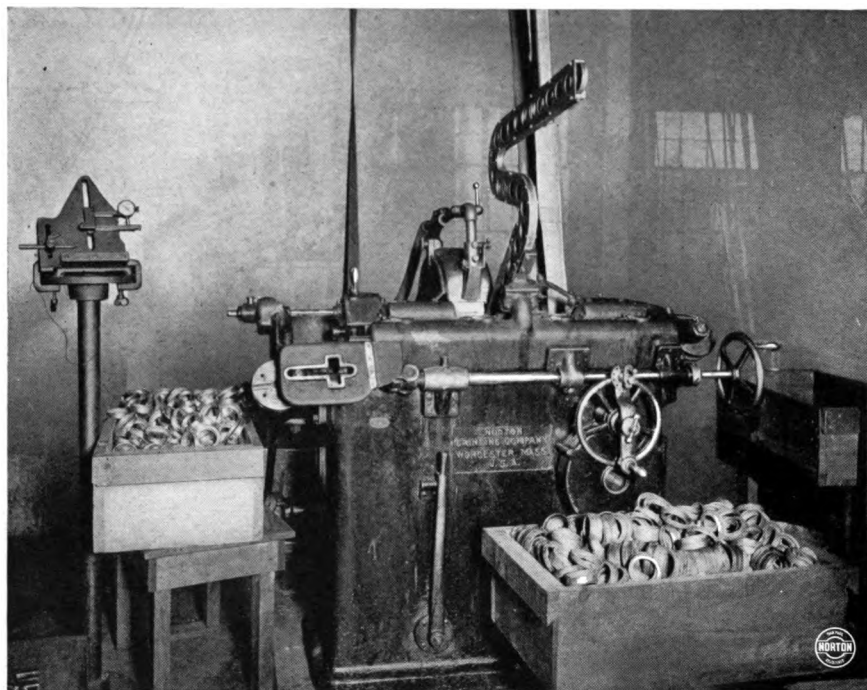
creases chattering; therefore increased production requires greater care in the use of steady-rests and the selection of the proper speed of the work. Small amount of production, in cylindrical grinding, requires less care and will give more perfect work. Which do we want—the greater production, with care and pains, or the smaller production with a lazy effort?

I doubt very much if it will ever be possible to produce commercial work that a determined critic cannot find some faint chatters in by lapping with a perfect lap and abrasive. But such tests are not sensible ones to apply to any ground work for the reason that anything requiring a more accurate surface must be lapped anyway.



Rolls for the Emergency Gates of the Panama Canal.

These flanged wheels are vanadium steel, case-hardened forgings, rough turned. Two thousand of them are being ground on Norton machines with Norton Alundum Wheels. These forgings could not be finished economically by any other method than grinding with a modern machine and grinding wheel. A grinding wheel with a face the full width of the surface to be ground and formed to fit the contour of the wheel is being used.



Four Rings a Minute—240 Pieces per Hour

To many who have never seen an automatic grinding machine in operation the illustration on this page should be of interest, especially to the master mechanic and efficiency engineer.

The photograph was made in the plant of The New Departure Mfg. Co., Bristol, Conn., where the Norton Automatic Grinding Machine is used for grinding peripheries of ball races varying in size from 1" to 5½" diameter, ¼" to 1½" in width. These rings are automatically chucked, rough ground and ejected at the rate of four rings a minute or 240 pieces per hour with a limit accuracy of .0005". In order to secure a very fine surface the work is then finish ground in the same machines. As the work feeds down the chute, one piece is released by a stop pin, drops between the chucks which open and close and automatically passes by

the wheel as many times as required to bring to correct size, when the chucks open, dropping the ring on an endless belt which carries it to the receptacle provided. In the meantime, a new piece is dropped into place and the process is repeated.

Accuracy and precision are shown in the manufacture of the product of this company as is evidenced by the Ames gauge, a precision measuring instrument shown in the picture. As the operator is required only to fill the chute and test the work from time to time on the gauge, one man can easily look after two machines.

These automatic machines can also be modified and made semi-automatic for grinding work on chucks. It can be applied to any form of chuck work for grinding external diameters.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Semi-automatic Attachment for Disk Grinding Machine. An economical arrangement for surface grinding large numbers of small castings. American Machinist, June 27th, 1912, page 1041.

Grinding Centers. A single means of getting rid of extremely sharp points on the centers of lathes and millers, making a true-running and durable point that will not bottom in the work center or break off. American Machinist, June 27th, 1912, page 1046.

Grinding a Curved Die. A method of grinding convex and concaved sections of

hardened steel dies with an Alundum cup wheel on a flexible shaft. American Machinist, June 27th, 1912, page 1045.

Combination Drill and Universal Grinding Machine. A new Grinding Machine is made by the Wilmarth & Morman Co., Grand Rapids, Mich., which is a combination drill and universal machine. Besides drill grinding it may be used for grinding forming cutters, gear cutters, side mills, hobs, taps and reamers, as well as for internal surface grinding. American Machinist, June 27th, 1912, page 1052.

Items of Interest

It is a fact that must be recognized that the production of the automobile of today with its ball and roller bearings, special alloy steels and precision in all its essential rotating parts, would have been practically impossible without the modern grinding wheels and the machines on which they are used.

The modern grinding wheel has made possible the success of the automatic machines in the cutlery industry.

When the waiter "pops" the cork and the sparkling bubbles effervesce into your glass, did it ever occur to you that the grinding wheel plays a part in the manufacture of champagne bottle stoppers?

In a large mail order house where the number of letters received daily runs into the thousands, a grinding wheel has been found to be the most practical device for

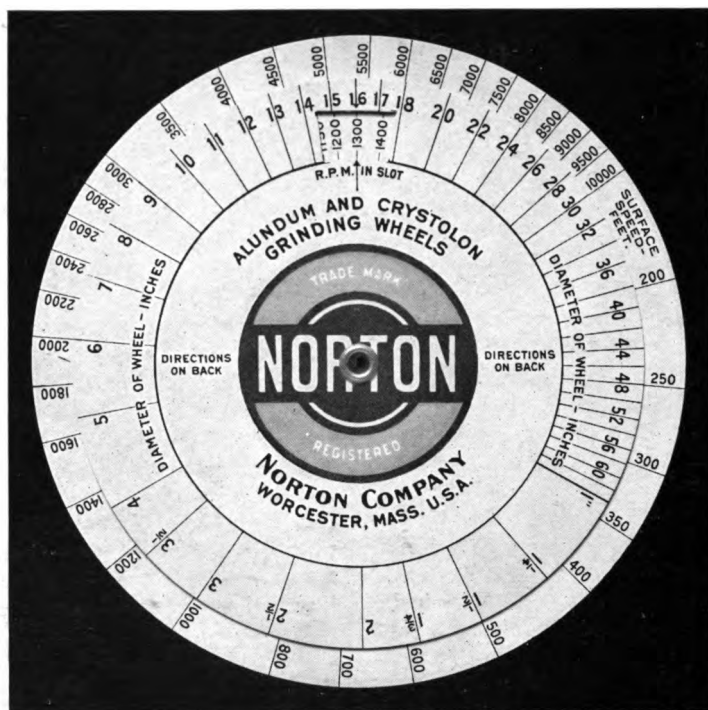
opening the mail. A bundle of letters is touched against the wheel and the ends of the envelopes are ground off without destroying the contents.

Only a few years ago there wasn't an artificial grinding wheel used in the glass industry and now there are thousands.

It wouldn't occur to many that the grinding wheel enters into the making of those fluffy, feminine feather boas. Crys-tolon wheels are used for grinding the ends of the feathers.

To the modern electric furnace abrasives may be attributed the direct cause of revolutionizing the marble industry.

The modern grinding wheel may be justly credited for a remarkable decrease in the death rate among workmen employed in the cutlery industry.



Speed Calculator for Grinding Wheels

With this little vest pocket novelty, it is a matter of but a few seconds to find the surface speed at which a grinding wheel is running when the diameter of the wheel and the revolutions of the spindle are known;

Or, to find the revolutions of the spindle necessary for the required surface speed when the diameter of the wheel and surface speed desired are known factors;

Or, to find what diameter of wheel is necessary for a given surface speed and given revolutions per minute of spindle.

This novelty is copyrighted by Norton Company and will be sent, free of charge, to any user of Norton wheels who requests it. Simply send us a postal-card request with your address.

Directions for Using this Speed Calculator

TO FIND SURFACE SPEED—Given diameter wheel and R. P. M. Place arrow

to R. P. M. in slot. On large disk, opposite wheel diameter, find surface feet. Example: Given diameter wheel 18", R. P. M. 1,300. Place arrow to 1,300 in slot. Opposite 18 small disk, find on large disk 6,150 SURFACE FEET.

TO FIND R. P. M. FOR SURFACE SPEED DESIRED—Place wheel diameter, small disk, opposite surface speed, large disk. R. P. M. found in slot under arrow. Example: Given diameter 12", surface speed 5,500 feet. Place 12, small disk, opposite 5,500 large disk, in slot under arrow find 1,750 R. P. M.

TO FIND DIAMETER WHEEL FOR GIVEN SURFACE SPEED—Place arrow under slot to R. P. M. Opposite surface speed large disk, find diameter wheel on small disk. Example: Given 6,000 surface feet, 2,900 R. P. M. Place arrow at 2,900 in slot. Opposite 6,000, large disk, find "8" the REQUIRED DIAMETER.

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

AUGUST

1912



Wheel Salesmen and Some of the Instructors
Norton 1912 Summer School

GRITS AND GRINDS

Vol. IV

August, 1912

No. 4

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The Norton 1912 Summer School

**Objects—The Manufacture of a Scientifically Developed Cutting Tool—
Lecture Courses on the Vital Subjects Pertaining to the Care and Use
of Grinding Wheels—Practical Demonstrations—The Important
Position of Artificial Abrasives in Modern Manufacturing—
The Laboratory a Factor of Progressiveness**

To those agents and salesmen who believe that success in selling grinding wheels depends entirely on inherited salesmanship, a course of instruction would be of little interest.

But that is not the view taken by the many Norton agents who gave their salesmen an opportunity at the Norton Summer Schools, to obtain a better knowledge of the care and uses of grinding wheels and the various conditions under which they are successfully operated.

While a conference for Norton Company's salesmen and demonstrators has been held regularly for a number of years and the policy of the company has been a liberal one in connection with giving individual or class instruction to men using and selling wheels, the Summer School for a large class course of instruction for agents' salesmen was begun in July, 1911.

The results fully demonstrated to the satisfaction of those agents represented that a thorough knowledge of the care and uses of grinding wheels is one of the big factors that enables a salesman to deliver the goods. Consequently the 1912 school, during the week of July 15th, was even better attended and the interest shown was indeed gratifying.

Although the quality of Norton Grinding Wheels is the highest obtainable and the abrasives used in their manufacture are the best that can be produced, their success is dependent in a large measure on intelligent use.

The purpose of this Summer School is to impart the knowledge gained through our many years of experience to our agents that they might in turn pass it along to their customers.

It is not unreasonable to expect that the many students, who labored in our shops, listened to technical lectures and discussion, and took part in practical demonstrations for a week, will be capable of dealing successfully with many grinding problems and know how to get the right kind of assistance from the factory. The Summer School, therefore, is just another kind of service which this company renders users of its products.

Following the students through the week's course will reveal the many reasons why such a course is of inestimable value to the salesman, the agent and the customer.

The trip through the factory, on arrival, had the effect of impressing upon the minds of the students that a Norton Grinding Wheel is a scientifically devel-



Ready for the Clams

The Summer School Terminated with an Automobile Ride and an Old-Fashioned New England Clam Bake at Lake Waushacum

oped cutting tool. Every little detail in the preparation of Alundum and Crysctolon; every operation in the making of the wheel is carried out with an exactness that is surprising to any visitor. It brought them in close touch with every step in the production of grinding wheels—mixing, drying, burning in the kilns,

truing, facing, bushing, balancing, grading, testing, inspecting and packing for shipment. It gave them an opportunity to learn what "Norton" quality is and why it is, and the reasons for the success of these products.

The elaborate and extensive equipment of chemical, mechanical, and research de-

partments for experimental work have brought grinding wheel manufacturing in this plant up to a high state of science.

Manufacture of Abrasives

An illustrated talk to acquaint the students with the development and manufacture of Alundum and Crystolon was the next step in the Summer School Course and the result as represented by the modern grinding wheel, made possible by the electric furnace, makes a story full of interest.

There is a vast difference in point of efficiency between the emery wheels of a few years ago and the scientifically constructed cutting tool of to-day. The problems which confronted the manufacturers, such as the difficulties of duplicating the product and bonding wheels to meet specific requirements, have been overcome by the use of electric furnace cutting materials. The quality is under control. The greatest advance in recent years in the making of artificial abrasives is the art of being able to fix the toughness or what may be called the "temper" and produce abrasives that possess the desired physical characteristics for each kind of grinding. This lecture pointed out how these things are accomplished and the many steps necessary in attaining the final result.

An explanation of the processes of manufacturing grinding wheels and the reason for each operation followed.

Grain and Grade

Perhaps the most important and interesting subject to the salesman is "Grain and Grade and the Conditions which Determine Their Selection." The determining factors of grain and grade are: speed of spindle, speed of work, conditions of repair of machine, wet or dry grinding, proper safety devices, weight of piece of work, kind of material, finish required, dimensions, broad or narrow contact. To these factors consideration must be given when selecting the wheel.

Selection of wheels, without weighing each of the above conditions carefully, is

purely guess-work and large users of grinding wheels to-day know that their successful selection depends on scientific knowledge of their uses. If the salesman wants the factory to give his customer the best service possible, he must learn to give the factory details that are clear, concise and thorough.

"Grits and Grinds" has published in the past, information on "Safety As Applied to Grinding Wheels." This important topic was not overlooked in the course.

Laboratory Work

The main purpose of laboratories for testing and experimental work is "Improvement of the Product." A knowledge of the properties of the materials which are used in the manufacture of abrasives and wheels, both crude and finished, their methods of manufacture, composition, nature and use, but more especially the underlying properties and principles governing their application, is essential in a progressive, modern manufacturing plant.

Experimental work is carried on in the laboratories to show the relative abrasive efficiency under various conditions of all the forms of abrasives, and in order to obtain a basis for developing new materials that will overcome certain difficulties in specific lines of work.

Other purposes of the laboratories are: to facilitate manufacture, to investigate grinding problems, to widen the field of usefulness of the product and to create confidence in the product. The quality of all crude materials is maintained at a standard. The laboratories work in connection with the manufacturing department to develop processes whereby grades of wheels can be obtained and duplicated with the greatest degree of satisfaction. Many instances were cited where the field of usefulness of abrasive products has been increased by reason of this experimental work; where problems in connection with grains and grades, speeds of wheels and other conditions are solved by experimental tests.

Considerable experimenting and in-

vestigation to ascertain the best methods of mounting, safeguarding, and operating grinding wheels has been done. The work of the several different departments of the laboratory and proposed plans which will enable this work to be pushed along with re-doubled vigor were outlined.

Details of Norton methods of bushing, facing, truing, mounting and balancing have been previously published in "Grits and Grinds." A thorough explanation of these processes and practical demonstrations of two hours each were given the students as well as demonstrations in grinding and the application of safety appliances.

Metals that are Ground

A treatise on the various metals of commerce, which constitute by far the largest portion of grinding problems that are likely to present themselves, served to instruct the students in regard to the physical properties of metals and better prepare them to meet such problems. The various classifications of iron—cast iron, wrought iron and steel—were defined and consideration given to the properties, characteristics and uses. Attention was drawn to the many kinds of steels and the different processes of manufacture.

This subject of metals and the selection of wheels for grinding them came in for a large portion of the week's discussion.

The grinding of castings—steel, malleable iron, brass, bronze, aluminum and other alloys—was presented in detail, emphasizing the many conditions which govern the selection of Alundum or Crysotol for grinding them.

It is almost impossible to mention a single manufactured article in the production of which a grinding wheel or abrasive material has not materially assisted. "Materials Other Than Metals That are Ground", therefore, proved to be an interesting subject. There are hundreds and possibly thousands of materials

or grinding operations that cannot be classified.

In connection with cylindrical grinding such salient features as the wheel, speeds, grains and grades required, cause and remedy of chatter, scratches, glazing, loading, comparative costs of the different methods as regards grinding and turning came in for much consideration. Demonstrations on Norton machines followed.

Other subjects taken up during the week were: "Norton Products Other Than Grinding Wheels," "Edging Tools," "Norton Alundum Refractories," "Advertising Methods," "The Value of Research Laboratories to Norton Company's Agents and Customers" and "Selection of the Right Type of Grinding Machine for the Work."

We have every reason to feel gratified by the outcome of the 1912 Summer School and believe that it will result in better service to the users of Norton wheels in the territories represented.

A list of the agents' represented and men in attendance follows:

Summer School Students, 1912.

- Canadian-Fairbanks-Morse Co., Ltd.,
Montreal, P. Q., Can.—J. A. M.
Taylor, J. J. Marnell.
- Carey Machy. & Supply Co., Baltimore,
Md.—I. S. Smith.
- Chandler & Farquhar Co., Boston., Mass.
—J. K. Wiswell, G. A. French.
- Chas. Churchill & Co., Ltd., London,
England—W. Haddock, K.D. Morgan.
- Cleveland Tool & Supply Co., Cleveland,
O.—F. C. Wittich, R. C. Herig.
- Alfred Herbert, Ltd., Coventry, England
—Thomas M. Barker.
- E. A. Kinsey Co., Cincinnati, O.—Ormond
C. Scott, F. C. Bentley.
- W. H. Neill Co., Louisville, Ky.—D. W.
Lawler, W. R. R. LaVeille.
- Norton Company, Chicago, Ill.—J. W.
Horne, W. I. Bretchneider.
- Norton Company, New York—H. K.
Dodge & G. M. Galloway.

Powell, Clouds & Co., Philadelphia, Pa.—
R. Pearce, A. Broaddus, J. Krause,
P. Powell.

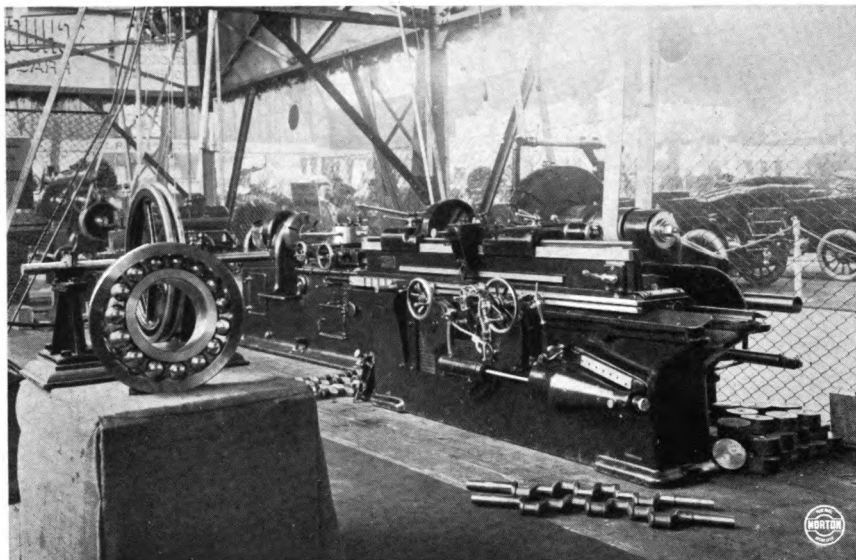
S. M. Price Machy. Co., Norfolk, Va.—
W. L. Graham, E. L. Parker.

Simonds Mfg. Co., Ltd., New Orleans, La.
—Bruce C. Somers.

Somers, Fitler & Todd Co., Pittsburgh,
Pa.—H. F. Kramer, J. S. Miller.

Vonnegut Hdwe. Co., Indianapolis, Ind.
—S. C. Klein, E. G. Vonnegut.

J. T. Wing & Co., Detroit, Mich.—H.
Stahl, Geo. Stuart, C. L. Gransden



A Norton Grinding Machine demonstration at a recent automobile show in Prague, Bohemia. H. Wickstrom, European demonstrator, reports that a good deal of interest was shown in the Norton method of producing accurate crankshafts because of the prevailing opinion that pins must be turned round first before they can be ground round. The shafts were ground from rough on all the pins and bearings, and the Norton method of machining such work was followed.

The Prague office of Schuchardt & Schutte, agents for Norton Grinding Machines and Norton Grinding Wheels, had charge of the exhibit.



INFORMATION DESIRED FOR PROPER SELECTION OF NORTON GRINDING WHEELS

PLEASE FILL IN THE BLANK SPACES AND GIVE INFORMATION AS ACCURATELY AS POSSIBLE
IT WILL ENABLE US TO INTELLIGENTLY MEET THE REQUIREMENTS

Firm _____ *Address* _____

1. Number of Wheels _____ Diameter _____ Thickness _____ Hole _____ 2. How mounted _____ Type of Machine _____ 3. Material to be ground _____ (a) If steel, is it hard or soft? _____ (b) Contact, wide or narrow _____ (c) If tool grinding, size and kind of tools _____ 4. Kind of grinding _____ (a) Is it free hand in connection with steady rest? _____ (b) Is it automatic, cylindrical, internal or surface grinding? _____ (c) Wet or dry? _____ 5. Revolutions per minute of wheel _____ 6. Revolutions per minute of work _____	7. Is machine arranged for variable speeds? _____ 8. Depth of cut to be taken _____ 9. Approximate size of pieces to be ground _____ 10. Kind of finish required _____ (a) Coarse _____ Medium _____ Fine _____ 11. Make of wheel previously used _____ (a) Grain and Grade _____ 12. Remarks: _____ _____ _____ _____
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NOTE—If it is intended to grind several kinds of material with the same wheel, please name each material in order that wheel selection may be properly made.

If the order is a "repeat" order, it is only necessary to give the date or number of the last order.

NORTON COMPANY,
Worcester, Massachusetts

921-6-12-66

The Use of Information Blanks like this Will Enable the Grinding Wheel Manufacturers to Deal Intelligently With Your Special Requirements. The Blanks will be Furnished on Request by Norton Company.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Small Direct Motor Driven Bench Grinder built by American Electric Tool Company, West Newton, Mass. American Machinist (European edition), June 29th, 1912, page 929.

Motor Driven Dry Grinding Machine, by Springfield Mfg. Co., Bridgeport, Conn. Three sizes of machines are built for accommodating wheels 12" in diameter with a 2" face, 18" in diameter with a 2" or 3" face, and 24" in diameter with faces either 3" or 4" wide. Iron Age, July 18th, 1912, page 127.

"Recently we had occasion to grind a lot of aluminum castings on an emery wheel and encountered considerable difficulty, as the aluminum stuck on the wheel. It was impossible to obtain a smooth and satisfactory surface with the wheel in this condition. Continually cleaning off the wheel with an emery wheel dresser consumed too much time. We then took paraffin wax and held it on the wheel to fill up the pores and proceeded with our grinding without any further trouble." American Machinist (European edition), July 13th, 1912, page 1001.

Internal Grinding Attachment on a Lathe. A very clear idea of the method employed by a well-known contract shop in getting out a rather unusual and fussy job of internal grinding is shown in the July 13th American Machinist (European edition), page 1002.

"Grinding Chilled Cast Iron Rolls." A very interesting discussion and analysis

of the problem of grinding chilled iron rolls. Article by J. H. Hollinger, Birmingham, England, gives reasons for the common difficulty in grinding chilled cast iron rolls. American Machinist, July 18th, 1912, page 115.

In the July 25th "American Machinist," page 163, are shown several illustrations of Portable Electric Driven Tools.

"Re-Grinding and Repairing Corrugated Flour Mill Rolls" by F. B. Jacobs. This article shows machinery and tools that are necessary. Machinery, July issue, page 827.

In the July issue of "Machinery," page 871, is an article by Chester L. Lucas on the Rivett Internal Grinding Machine in the automobile factories.

A simple means of facilitating the grinding of circular forming tools is explained in the July issue of Machinery, page 881.

"A grinding attachment intended to correct errors in forming cutters caused by the hardening process." Machinery, July issue, page 883.

Machine improvised to grind the interior and exterior of the steel ring that is forced into the head of a swaging machine. Machinery, July issue, page 883.

Bench-Lathe Attachments. Six bench-lathe attachments, designed and built by Elgin Tool Works, Elgin, Ill., are shown in the July 4th edition American Machinist, pages 40-41.

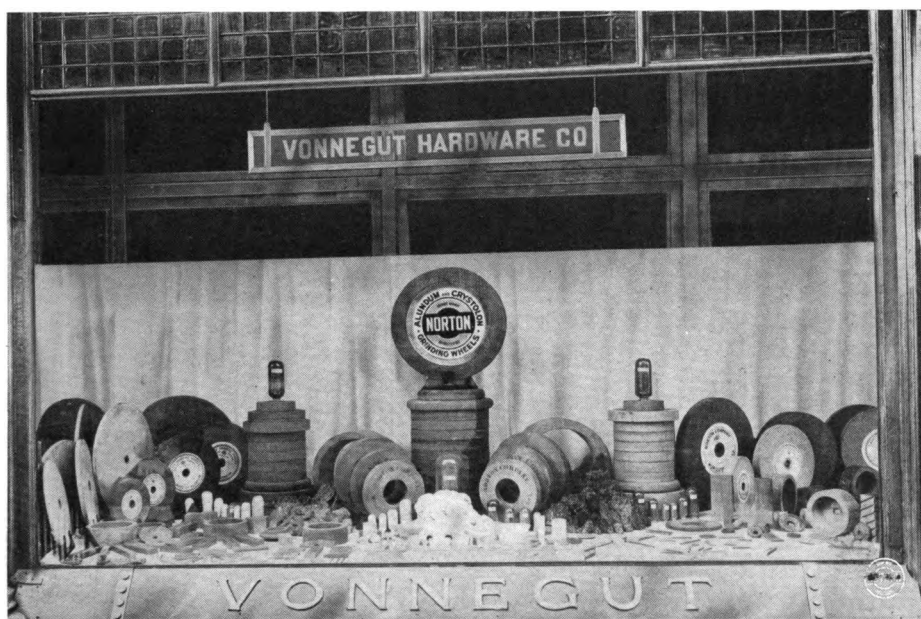
GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

SEPTEMBER

1912



Some Agents Have the Impression That a Grinding Wheel Window Has no Special Interest for the Passing Public. The Recent Efforts of Vonnegut Hardware Co., Indianapolis, Ind., to Attract Attention to Their Window was not Without Good Results, as Will be Seen From the Above Reproduction from a Photograph. This Kind of a Window Display is Sure to Create Unusual Interest,

GRITS AND GRINDS

Vol. IV

September, 1912

No. 5

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Edging Tools

**Natural Stones Replaced by Manufactured Stones. Care of Oil Stones.
Points About Selecting Oil Stones to Meet Requirements.
Uses for Coarse, Medium and Fine Grits**

By C. F. Gillette

The sharpening or edging stone is one of the most ancient tools. There is no doubt that it had its advent before the time of that first well-known worker in metals—Tubal Cain. Even before this time men moulded and shaped their stone instruments by rubbing them on rocks in the ground which possessed abrasive qualities. The oldest record of a sharpening stone is a small statue kept at the Uffizi Gallery at Florence, known as "The Grinder." It represents an ancient worker sharpening a sickle upon a rectangular shaped stone. For untold centuries, from the time man first discovered the value of a cutting edge, to some 15 years ago, practically the same method was used to give tools a cutting edge. Stone-axes, arrow-heads, battle-axes, the mediæval sword, planer knives or lathe tools were all given a cutting edge by rubbing or grinding them on a piece of natural stone.

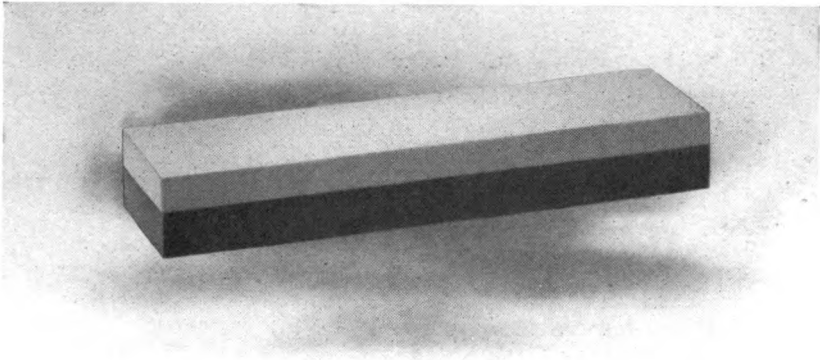
For nearly a century the Washita and Arkansas natural stones, quarried in the mountains of Arkansas, U. S. A., held honors in the mechanical world as high-grade tool sharpeners. Both stones were of practically the same general appearance, but the Arkansas was considerably harder, more compact and finer grained. This stone is still highly valued, especially among engravers, watchmakers, die-sink-

ers, wood and ivory carvers, surgeons—users of very fine tools. But owing to the fact that it is quarried and shaped with difficulty and to a limited supply of good Arkansas rock, it is necessarily high priced.

Washita stones being more porous and considerably softer, were more widely used by carpenters and joiners. However, it was rarely possible to secure a good natural sharpening stone, of uniform grit, free from hard or soft spots, streaks or particles of metallic iron. The price of a stone was governed by its weight, for to cut them into uniform stock sizes would make the cost prohibitive.

Near the close of the nineteenth century the market was flooded with artificial oilstones made of quartz, sand, emery or corundum. Quartz and emery have never been found satisfactory for mechanics tools, except for the rough grinding of very dull or blunt tools which are afterwards finished on an oilstone. An emery stone, especially, must be used with care, as fine edge tools can be easily damaged by the inexperienced hand. These stones usually became glazed or were worked out of shape after short usage.

In 1897 the Norton Co. introduced a new artificial oilstone, made of India Corundum. At that time Corundum was the hardest material in the world available



in sufficient quantities to be used for abrasive purposes. This material is nearly as hard as the diamond, and being much harder than quartz, emery or sandstone, it cuts metal much faster. The India Oilstones were at first looked upon with suspicion, due to the many unsuccessful stones then on the market which either glazed badly, wore unevenly or crumbled when wet. However, they soon gained for themselves an enviable reputation among users of edge tools.

Since 1904 Alundum, an artificial corundum of great purity, has been used almost exclusively in the manufacture of the India Oilstones resulting in even better cutting qualities and higher efficiency.

Where remarkable fast-cutting properties are preferable to durability of the stone, and the fineness of the edge is not an important consideration, the line of Crystolon (Carbide of Silicon) stones manufactured by Norton Company meets the requirements. They are especially adapted to sharpening general wood-working tools. Carbide of Silicon crystals are very brittle and break down rapidly presenting new sharp cutting points. This means quick sharpening, but of course at the expense of stone wear.

Just as the successful use of grinding wheels depends largely on condition so does the use of sharpening stones.

A carpenter does not expect a rip-saw to do the work of a cross-cut saw, nor the coarse cross-cut saw to do finer joiner-work. You would not sharpen a razor on a scythe stone, nor a scythe on a razor hone. The same idea holds with other sharpening stones. Many stones are condemned when the fault lies either in not having selected the right stone for the work, or in not having taken proper care of it. A good stone can be ruined by improper usage or lack of care. The mechanic who expects one oilstone to grind a dull-nicked tool and at the same time impart a keen razor edge, using any kind of oil that happens to be at hand, leaving the dirty oil on the stone to dry in, or leaving the stone around in the dust and dirt of the shop will never have a good oilstone. No good mechanic or carpenter would think of using his other tools in this way, yet many treat their oilstones in this fashion.

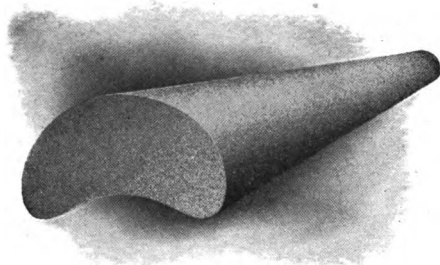
Care of Oilstones

There are three objects to be attained in using and caring for an oilstone: first,—to retain the original life and sharpness of its grit; second—to keep its surface flat and even; third—to prevent its glazing.

To retain the original freshness of a stone, it should be kept clean and moist. To let an oilstone remain dry for a long

time or expose it to the air tends to harden it. A new stone should be soaked in oil for several days before using. All India and Crystolon stones are oil-filled by a patented process before leaving the factory, which insures a moist, oily, sharpening surface with the use of only a small quantity of oil, and eliminates a very disagreeable operation.

To keep the surface of an oilstone flat and even merely requires care in using. Tools should be sharpened on the edge of the stone, as well as in the middle to prevent wearing a trough-shaped depression. It is impossible to prevent a stone



becoming slightly hollowed with long usage, but this can be remedied by grinding the stone on the side of a grindstone or by rubbing it down with an abrasive brick.

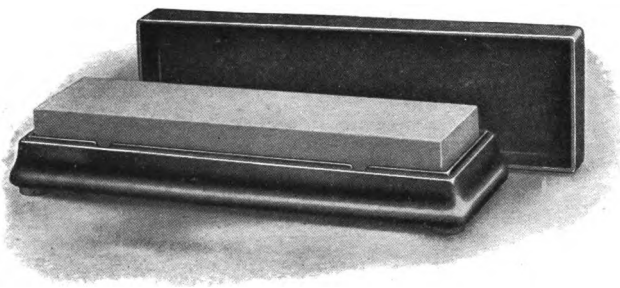
To prevent an oilstone glazing, the user must first understand what causes a stone to glaze. This can best be explained by showing why oil and water are used on sharpening stones, and how they should be used.

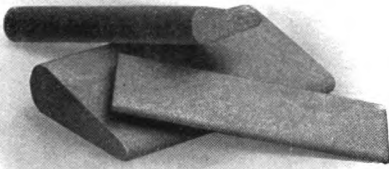
The word "Oilstone" has come to be applied to all stones used for sharpening

mechanics' tools, from the fact that it is necessary to use oil on most of them for two purposes: first, to prevent the stone from heating the tool, which draws its temper and ruins the best tool instantly; second, to keep the particles of steel ground off the tool from entering the pores of the stone, which would soon fill them up producing a glazed surface.

Most coarse-grained and all soft stones can be used successfully with water, although they may be generally termed "Oilstones." On such stones, water should be used plentifully to carry off the powder rubbed up by the tool. Most water-stones are quick cutting and leave a coarse edge, but a much finer edge can be procured upon the same stone by using just enough water or oil to rub up a paste. This paste when kept on the stone will give a finishing edge, but should be thoroughly cleaned off before putting the stone away.

Fine-grained, hard stones should always be used with oil, as water is not thick enough to keep the steel out of the pores. The dirty oil should always be wiped off the stone, thoroughly, as soon as possible after using it. This is very important for if left on the stone, the oil dries in, carrying the steel dust with it and causing the stone to glaze. Cotton waste and kerosene oil, gasoline or ammonia are best for cleaning a stone and are always to be found in a shop. Never use turpentine to clean a stone, for it is gummy and fills the pores of the stone. Some carpenters use shavings, but these are apt to leave the stone full of dust. An ordinary clean rag would be better.





How to Select Oil Stones

The question now arises, how shall we select a stone for our use? First, we should consider the purpose for which a stone is to be used. Do we want a fast cutting stone in preference to a slow-cutting stone? There are three kinds of cutting edges—coarse, medium, and fine; also, oilstones are made in three grades—coarse, medium, and fine.

The coarse stones are used for sharpening large and very dull tools, nicked tools, machine knives and for general use where fast-cutting is more desirable than fine finish.

The medium stones are for mechanics' tools in general; more particularly those used by carpenters and in wood-working establishments. This grit gives a medium fine edge.

Fine stones are used by machinists and engravers, die workers, instrument makers and all who require a very fine, keen edged tool.

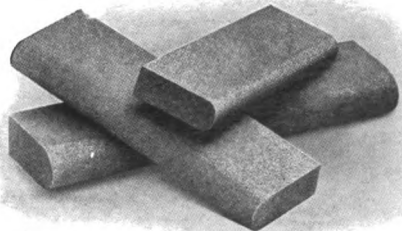
Practically all the coarse-edged tools are knives. By "coarse" edge we do not mean it is not a sharp edge. The ideal edge for a carving knife is a "coarse" edge—best because such an edge will do its work perfectly and because to take extra time to get a finer edge on a slower cutting stone would be just a waste of time. Knives do not require a fine edge because they are always used with a diagonal or saw-like motion. This adds to the cutting efficiency and at the same time the slight coarseness of edge, in its turn, adds to the saw-like effect, again making the cutting easier. These tools include canvas cutting knives, carpet

knives, carving knives, bread knives, paring, kitchen, household and farm knives of all kinds. Some of these tools require a finer edge than others, but all can be given the best edge for their work on a coarse stone.

Medium edge tools require more smoothness than a coarse edge affords but yet do not need extreme fineness. These are the tools used by most mechanics—more particularly the broad, bevel-edged tools such as chisels, planes, draw knives, and others used by carpenters and wood workers.

One would naturally suppose that to secure a medium edge he should use a stone of medium grit. This is not entirely correct. The average mechanic buys the medium grit stone in order to secure both fast cutting and a fine enough edge from one stone. Except for special uses, the more satisfactory way is to use a coarse stone for rapidly cutting the edge down until it is ready to finish and then to finish on a fine stone to whatever degree of fineness is desired. For this reason, a Combination stone, which unites a coarse stone and a fine stone, is more useful than a medium stone. Combination stones are becoming more and more popular among users of oilstones.

The fine edged tools are for special purposes, being largely used in the professions. The surgeon and dentist, leather workers and engravers like them. The scientist uses them in the preparation of specimens for the microscope. It is also reported that all the barbers along the Pacific Coast are searching the hardware stores for fine India stones, which they





There Are but Few Lines Handled by the Hardware Store that Make Such Good Window Decorating Material as the Lines of India and Crystolon Oil Stones in Their Great Variety of Shapes, Sizes and Grits.

use as razor hones. These fine grit stones really give good satisfaction and the demand for them has been very high in that section of the country.

In conclusion, it may be repeated that while natural stones give satisfaction, the user is not sure of a good uniform stone, free from hard or soft spots and foreign matter. The Norton artificial stones give much better satisfaction, being of a uniform grit and hardness and of proved cutting ability. The India stones especially have worked their way into the hearts of all oilstone users who swear by their wonderful achievements.

WHAT SHARPENING MEANS

It is not merely the friction between the stone and the steel that brings the latter down to an edge. Sharpening means *cutting*.

Every sharpening stone is a mass of minute crystals—infinitely sharp little

cutting points each of which is harder than steel.

The coarseness or fineness of these crystals, their hardness and their brittleness or toughness—these are the things, which, in various combinations, mark the differences between the several kinds of sharpening stones, making one kind better for its own purposes than another.

You would not think of sharpening a razor on a scythe stone. The scythe stone and the razor hone are the two extremes. Between them lie the various stones used in shops, as well as on the farm and in the home.—From "How to Sharpen"—by Pike Mfg. Co.

The aim of the modern grinding wheel manufacturers is to scientifically develop wheels for each class of grinding and for the conditions under which they are to be used.

Advantages of Artificial Stones

Uniformity of Abrasive Grain—Evenness of Texture—Exact Duplication
Possible—Oil-filled and Ready for Use

One of the chief advantages which India and Crystolon Sharpening Stones have over Natural stones is the absolute uniformity which it is possible to impart to the coarseness or fineness of the crystals. Since, as stated, the degree of coarseness is one of the prime considerations in choosing a stone, it becomes a matter of real importance to be able to control this and thus to secure a perfect stone with either coarse, medium or fine grit.

A second advantage, fully as great and possible only to artificial stones, is the unvarying hardness and texture throughout the stone due to the scientific "bonding" together of the crystals. This makes it possible to absolutely avoid all of the soft spots, hard spots, crevices, pebbles and other defects which sometimes come to light in even the best natural stones.

This fact also enables the user of either an India or a Crystolon stone to buy a new stone of the same grit with the certainty that it will be precisely what he wants, a duplicate of his former stone.

An exclusive feature of India and Crystolon stones is that they are oil-filled, and by a patent process which gives them remarkable freedom from glazing. This also makes them ready for use with only a slight application of oil as soon as purchased and avoids the necessity of soaking them for days in oil as must be done with all other oilstones.—From "How to Sharpen"—by Pike Mfg. Co.

SHARPEN AGAINST THE EDGE

One rule that has very wide application in using cutting tools is to sharpen against the edge.

With two exceptions all kinds of sharpening (both on grinders and oilstones) are

performed with the edge of the tool working against the stone. The exceptions are, (1) when sharpening on leather, as with a razor strop; (2) when the tool itself is held still while the whetstone or oilstone is moved to do the sharpening—as in sharpening a scythe or sickle with a whetstone or in sharpening the inside of a gouge or other concave edge with an oilstone slip. The reason for sharpening against the edge is that this results in less "wire edge."

Many people lay a blade on an oilstone and proceed to sharpen it by a circular or rotary movement. With a pocket knife or other short blade, this will put on an edge in time. But straight strokes sharpen more quickly. Moreover, in the case of chisel-like tools this rotary motion constantly changes the angle at which the tool is held and prevents the edge from being true.—From "How to Sharpen"—by Pike Mfg. Co.

The greatest advance in recent years in the making of artificial abrasives is the art of being able to fix the toughness or what may be called the "temper."

With the exception perhaps of a very few grinding operations where conditions are out of the ordinary, Alundum Wheels should be used for steel grinding.

The conditions that must be taken into consideration before selecting the abrasive and the grain and grade are so many that it is impossible to lay down set rules for the selection of a grinding wheel.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

"A Few Universal Joint Operations." Article showing special machinery used in grinding the insides of forks of universal joints, also the center blocks. Illustrated with cuts and detailed descriptions of methods employed. *American Machinist*, Aug. 22, 1912, page 307.

A Polishing Machine, by E. A. Dixie. This machine was built several years ago by The Frick Company, Waynesboro, Pa., for grinding and polishing the flat surfaces on Corliss engine cylinders. *American Machinist*, Aug. 22, 1912, page 318.

Multiple Key Shaft Grinding Machine. Built by the Bath Grinder Co., Fitchburg, Mass. Designed to grind simultaneously, with a formed wheel, the side of two keys and the radius between an integral multiple key shaft, or sliding gear shaft, for an automobile transmission case. The machine is equipped with a safety hood, and water attachments for wet grinding. *Iron Trade Review*, Aug. 1, 1912, page 210.

Automatic Saw Sharpening Machine. Designed to sharpen by grinding high or low carbon, solid or inserted-tooth saw blades, by Newton Machine Tool Works, Inc., Philadelphia, Pa. *Iron Trade Review*, Aug. 1, 1912, page 214.

Method of Grinding Calender Roll in an 18" Engine Lathe is described in the Aug., 1912, issue of *Machinery*, page 967.

Unimatic Tool Room Grinding Machine. By Walker Grinder Co., Worcester, Mass. *Machinery*, Aug., 1912, issue, page 973.

"Internal Grinding of Cams," by F. B. Jacobs, explaining how steel cams may be ground internally on a home-made machine instead of lapping with a lead lap and spindle. *American Machinist*, Aug. 15, 1912, page 269.

"Grinding Thin High Speed Planer Tools" by Rob. Lowe, Jr. *The Woodworker*, Aug., 1912, page 38.

A new magnetic chuck, for holding automobile pistons for their final grinding, is described in *American Machinist*, Aug. 15, 1912, page 266. The chuck is built by D. & W. Fuse Co., Providence, R. I.

Electrical Tachometer. A simple electrical tachometer, which can be used for measuring spindle speeds on grinding machines by means of magneto connected to a volt meter, is described in *American Machinist*, Aug. 15, 1912, pages 267-268.

A foreman recently stated that he requires every grinding wheel in his department to be inspected each day. A rigid enforcement of this rule is a big factor in accident prevention.

The responsibility for the proper selection, mounting, truing, oiling and general care of all grinding wheels should be delegated to one competent person in all shops where considerable grinding is done.

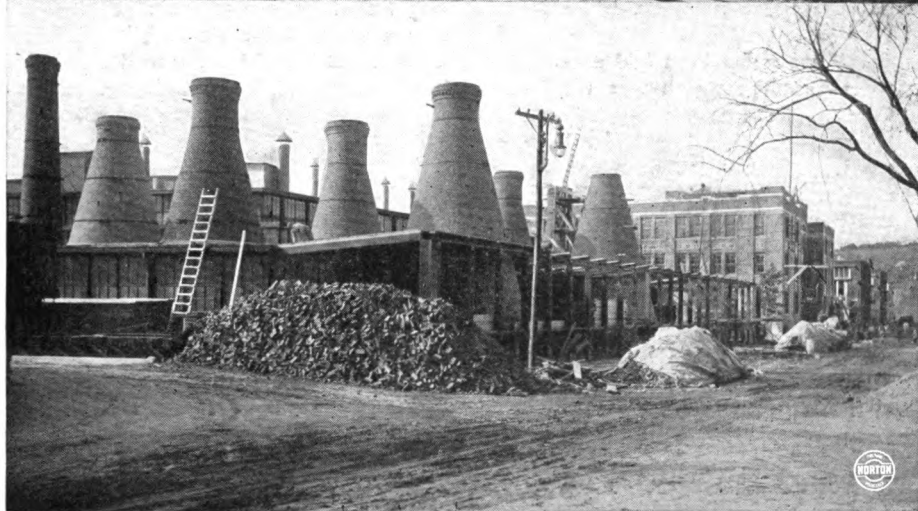
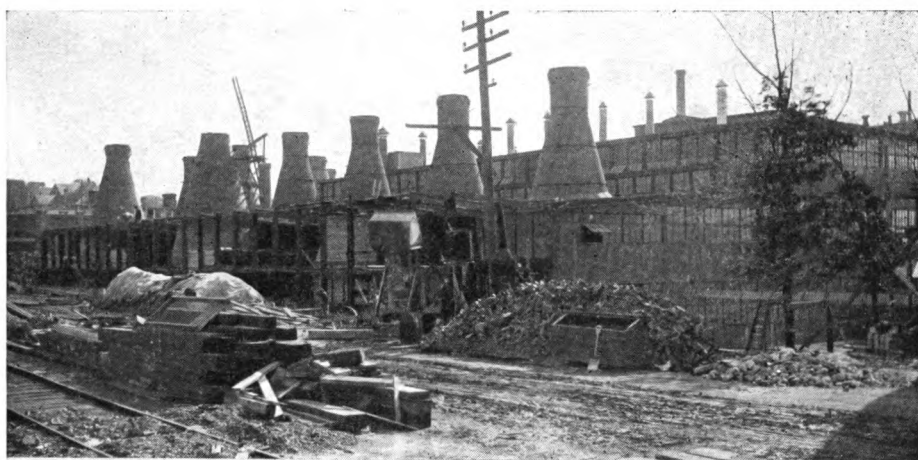
GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

OCTOBER

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Views at the Norton Works Where New Kilns, Factory Additions and New Administration Building are Being Erected to Meet the Increased Demand for Norton Products

GRITS AND GRINDS

Vol. IV

October, 1912

No. 6

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Economy in Cheap Turning and Grinding

An Example that Shows the Cost for Wheel, Diamond and Power to be of No Account When Compared to the Great Saving in Time and Labor Over the Older Methods

By C. H. Norton

There is a belief in the minds of many mechanics that while it is true that there is less labor when producing cylindrical work by first roughing that work very crudely and cheaply and then grinding off the remainder of the stock with a modern, heavy grinding machine using a modern wide-faced wheel, the cost for wheel and power, diamond, etc., is really greater than to turn very carefully, leaving a very few thousandths for grinding, using a lighter and less expensive grinding machine and a narrower, less expensive wheel.

The writer has been told a number of times that the reason why the Norton Grinding Company advocated the use of a heavy grinding machine and a large, expensive wheel was that they were interested in the making of grinding wheels and the selling of them; therefore, they were desirous that grinding wheels should be used up as rapidly as possible and that this was their reason for making a powerful grinding machine.

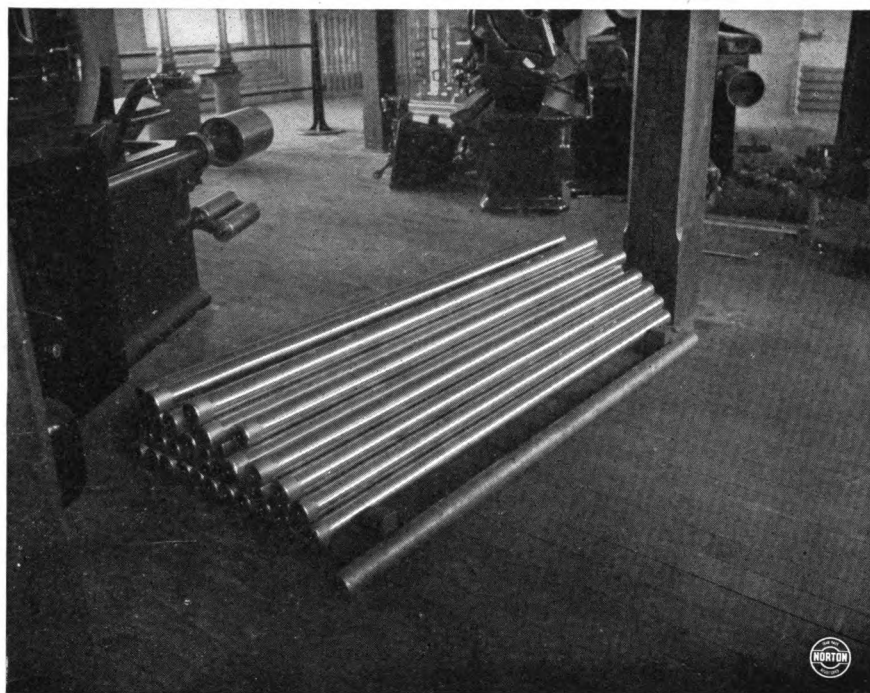
Probably not all doubters take this view exactly, yet there are still a great many people who believe that it is more expensive to grind work than to turn it, and that grinding should be used only for the correction, or the very last refining process. In fact, some grinding machine

makers still contend that the only economical way to produce cylindrical work is to first turn it carefully and exactly in an accurate lathe by a good workman and then grind off only sufficient to refine that work to the necessary degree of refinement that was impossible to obtain by the lathe.

The following example is a good illustration of what is accomplished with modern, heavy grinding machines and cheap turning:

A lot of 60 countershafts, 35 point carbon steel, finish size $2\frac{3}{16}$ " plus or minus .0005", 66" long, turned 8 pitch, leaving about $\frac{1}{32}$ " for grinding, were ground complete at the rate of 35 minutes each. Cubic inches ground off 278; 20.7 cubic inches of steel removed for every cubic inch of wheel wear. Total cost of wheel for 60 shafts, thirty-eight cents. Total cost for power, thirty-five cents. Wheel used, 24 combination grade L, Alundum. Radial depth of cut (when roughing) .001". Radial depth of cut (when finishing) .0005". Surface speed of work (roughing) 42' per minute. Surface speed of work (finishing) 35' per minute. Table traverse (roughing) $11\frac{1}{4}$ ' per minute; table traverse (finishing) 10' per minute. Steady-rests—"Multiple system."

Any one accustomed to the ordinary cost



Countershafts Ground on Norton Grinding Machines

of producing shafts must readily see that the cost for wheel, diamond and power is lost in the great saving made over the older methods of accurate turning and light grinding.

There is also a popular notion that the longer it takes to grind a piece of work the more expensive that work must be. The contrary is true in most cases; that is, work turned so cheaply and so roughly

that the grinding time may be increased three or four times, yet the total saving on that work will be very great. The saving due to the use of the modern grinding machine is made when roughing the work preparatory to grinding, and the cost for wheel and power is insignificant being no greater than the cost for steel turning tools for lathe work.

To Meet the Increased Demands

Extensive Improvements Being Made at the Norton Works—New Kilns—Factory Additions—Administration Building—To Meet the Growing Demand for Norton Products

It will doubtless be of interest to all large users of Norton products to learn that strenuous efforts are being put forth to meet the constantly increasing demand for them. Extensive improvements are being made throughout the plant and

elaborate plans are under way for increasing the productive capacity of every department that customers may be assured of reasonably prompt deliveries during the coming year.

The six large kilns now rapidly ap-

proaching completion, in addition to the six finished last year, will greatly add to the productive facilities, making the kiln capacity more than double that of any similar plant in the world.

To keep pace with the demand, the mixing, truing and turning rooms had to be enlarged in proportion. A new building just completed, known as the Abrasive Storage Building, permits the necessary increase of facilities in these departments.

The line of Norton Alundum Refractories and Laboratory Ware, only recently introduced on the market, is destined to a place as high in its field as Norton Grinding Wheels and Sharpening Stones now hold among manufacturers and mechanics which is evidenced by the growing demand for these goods. An addition being made to Plant 2 will make room in the Norton works for the growth and further development of this line.

With the increase in popularity of Norton products, there must be a corresponding increase in the clerical force necessary to take care of the general office work. This enlarged office force can no longer be accommodated in the present quarters and they are compelled to vacate to make

room for better accommodations in the shipping and stock departments.

The Norton Research Laboratories, which have become a vital factor in developing and maintaining the highest quality of product, and in rendering valuable service to users of Norton products by way of experimental work, have grown beyond their present quarters.

This growth has made necessary a new three-story Administration Building, now nearing completion, which will provide ample room and splendid quarters for both.

With the completion of the Administration Building and other improvements now being made, the appearance of the entire plant will be changed considerably. The frontage will be on New Bond St., which will be a model industrial avenue, reflecting the progress of modern times and the tendency toward attractiveness and sanitation in modern manufacturing plants.

This item is published in "Grits and Grinds" to acquaint the users of Norton products with the efforts being put forth to facilitate quicker and better deliveries, and to call attention to the fact that Norton quality and Norton service to the consumer are increasing the demand for Norton products.

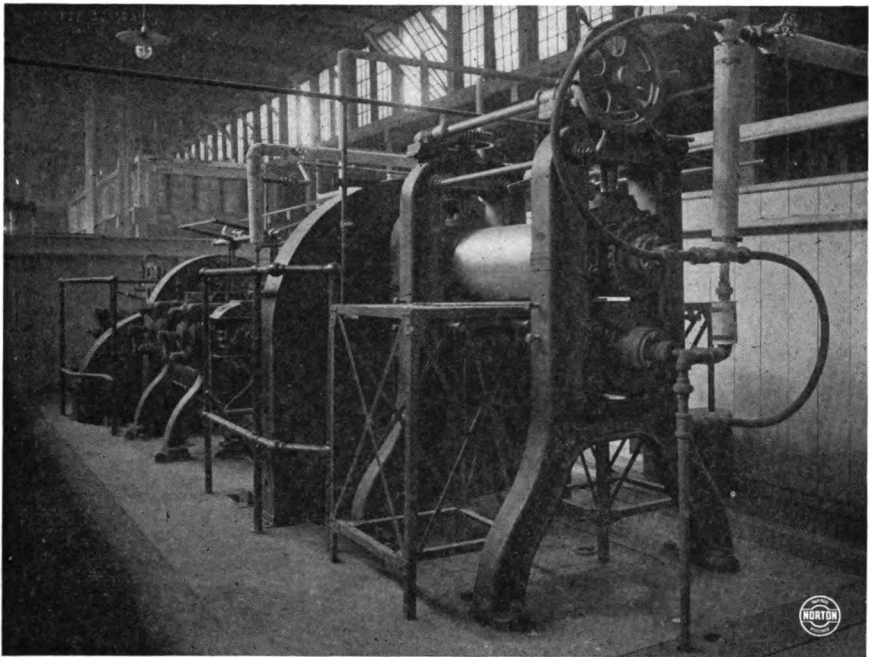
Vulcanite Wheels Added to Norton Products

To meet the demand for a wheel that will perform a class of work for which wheels bonded with vitrified, silicate or elastic bonding materials are not exactly suited, vulcanite wheels have been added to the Norton products. Vulcanized rubber when bonded in the proper manner with abrasive, either Alundum or Crystolon, forms a very hard and dense mass, of high tensile strength, combined with a certain amount of flexibility. These qualities permit of the wheel receiving rough treatment and at the same time provide a high margin of safety.

As the methods and processes involved

in the manufacture of vulcanite wheels are entirely different from any of those now employed, considerable careful and painstaking experimental work was carried out in the development of this process. The materials that are employed as the bonding agents are the best and most efficient that can be obtained.

The manufacturing operations consist essentially in mixing, calendering and vulcanizing. The mixing is accomplished on the mixing machine and consists in obtaining a perfect and homogeneous mixture, first of the bonding materials and then of the abrasive. The mixings are



Calender Roll Used in Making Grinding Wheels by the Vulcanite Process

then rolled to the proper thickness in the calender. They are then cut out, baked and finished in the regular manner.

A careful record is kept of the composition and hardness of all wheels made. They are tested at an excessively high rate of speed. This speed is much higher than would ever be employed in practical work.

The equipment as now provided will permit of the manufacture of wheels up to

22" in diameter and from $\frac{1}{8}$ " to 1" in thickness. Wheels as thin as 2mm ($\frac{1}{12}$ ") may be made in the finer grades.

Vulcanite wheels are used in cutting off work, cutting carbons, stove grinding, in the marble industry and in fluting drills, taps and dies; in certain kinds of aluminum grinding operations, in silver grinding and in many other operations where a strong and tough wheel is required.

Alundum Refractories

For the past ten years Alundum has been widely known as an abrasive of great value but comparatively few appreciate that it possesses qualities or properties that make it invaluable for the construction of pieces of apparatus for high temperature and laboratory work.

The most important properties are its high melting point, 2050 degrees C., and high thermal conductivity; that is, its property to transmit heat nearly twice as rapidly as clay and one and a half times faster than porcelain. It has a comparatively low coefficient of expan-

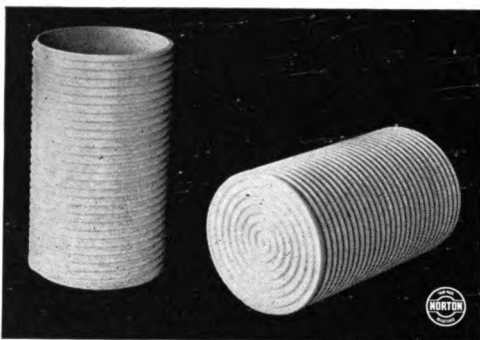
sion, being .0000071 per degree C. It will not conduct electricity and becomes a better insulator than porcelain at high temperatures.

Alundum is chemically inactive and when made up into crucibles or other forms of laboratory apparatus it is not appreciably attacked by the strong acids, and only slightly by alkalis.

In the construction of small furnaces for general laboratory work or making heat tests on steels, Alundum bonded in the form of cores as shown by the following cut have been found very satisfactory.

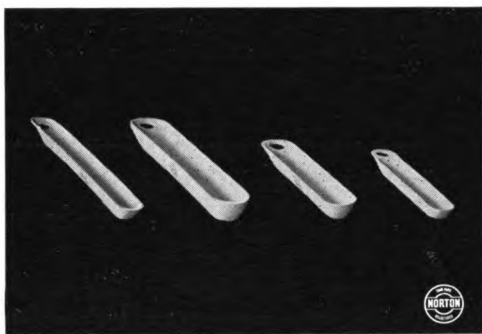
This success is due to the properties of Alundum, viz.: high melting point, low coefficient of expansion, chemical inactivity and high thermal conductivity.

These cores are made by bonding the Alundum grain with a suitable ceramic bond and moulding in the shapes of cylinders having a thread on the outside large enough to accommodate the resistance wire which may be wound either in a single strand or in the form of a helical coil, depending on the size of the core and the length of wire necessary to give the required temperature on a given voltage. After the wire is in place,



Electric Furnace Cores

manufacturers where from fifty to one hundred carbon determinations are made daily, combustion boats made of this material will be found to be of great assistance, owing to the high thermal conductivity and chemical inactivity.



Alundum Combustion Boats

it is given a coat of Alundum cement and allowed to dry. On heating up to a good, red heat, this cement vitrifies more or less, forming a compact and neat heating element for the furnace. This unit is then placed in a suitable container and a heat insulating mixture such as magnesium oxide and asbestos is packed around it.

Temperatures of 1050 degrees C. or 1940 degrees F. and lower can be maintained indefinitely.

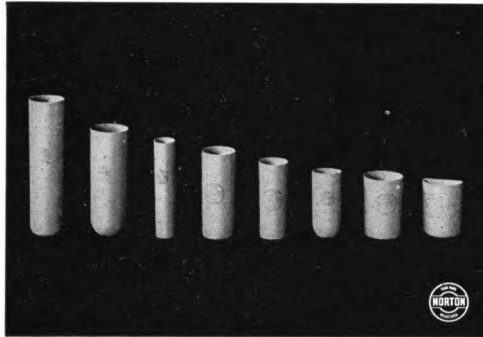
Other types of furnaces, tubes and muffles are being made of Alundum.

In the laboratory of the steel

Owing to the rapid advance in the price of platinum, this material is becoming more prominent. Crucibles made of Alundum have the added advantage of being porous, making them valuable in the laboratory in replacing filter paper and the ordinary porcelain Gooch. For burning off precipitates and washing organic material they are unexcelled, which is due to the above mentioned properties in connection with their porosity.



Alundum Crucibles



Alundum Extraction Thimbles

Among other valuable articles made of Alundum may be mentioned extraction thimbles, used in the laboratory for the determination of fats and oils, and in feeds, soaps and other organic materials; pyrometer tubes for the protection of

thermo-couples used in measurement of high temperatures; parts of gas furnaces; cements and filter tubes; plates, dishes and discs for the filtration of large quantities of water and various other liquids.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have appeared in Recent Issues of Technical and Trade Publications

Article entitled, "National Automobile Factory Methods," describing cylinder grinding and valve grinding. *American Machinist*, Sept. 5th, 1912—page 409.

"Grinding Fixtures." Fixtures for surface grinding gas engine gear plates and for grinding double bearing caps. *American Machinist*, Aug. 29th, 1912—page 362.

Portable Grinding Machine. Chicago Pneumatic Tool Co., Chicago, Ill., have recently put on the market a portable pneumatic grinding machine. It will

mount a grinding wheel 8" in diameter with a 1" face, and the total weight of machine is about 20 lbs. *Iron Age*, Aug. 29th, 1912—page 481.

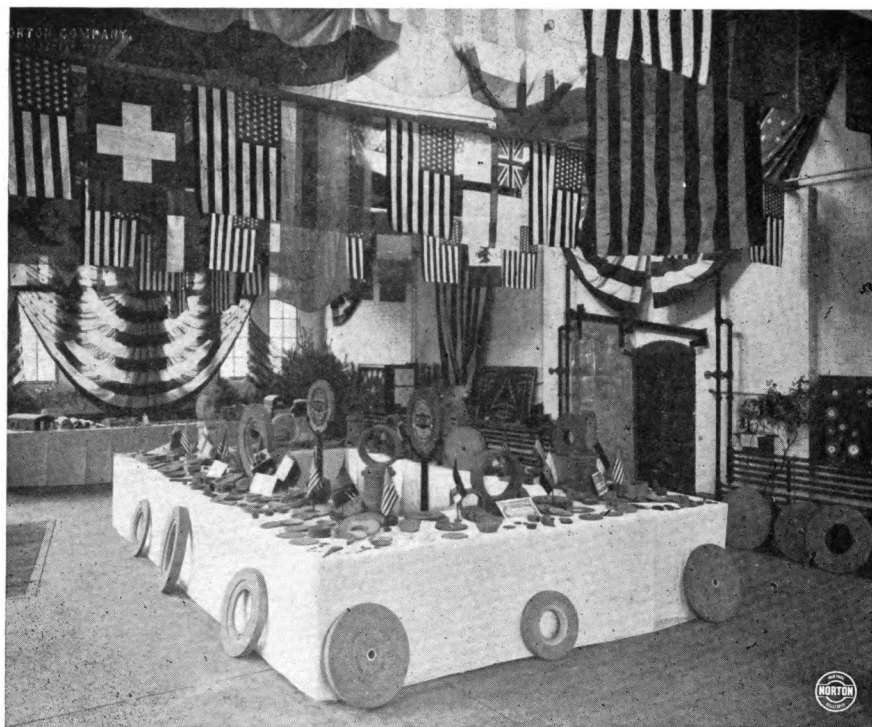
"Tool Post Grinder for Bench Lathe." This article explains the way a small tool post grinder may be used in grinding and backing off a variety of mills and milling cutters in manufacturing shops, and also in building special machinery and tools. Detailed description of the grinder is given. *American Machinist*, Sept. 5th, 1912—page 404.

Article on internal grinding and lapping of bushing for drill jigs. Machinery, Sept. 1912—pages 13-15.

Chas. H. Besly & Co., Chicago, Ill., are manufacturing a 53" vertical spindle disk grinder for jointing or flattening such work as foundry flasks, meter cases, gear cases, split bearings, etc., where it is not necessary to grind to any size or given angle. The grinder is 34" high and weighs complete about 6,000 lbs. American Machinist, Aug. 29th, 1912—page 371.

The Advantages of the Norton Alundum Filter in the Filtration of Soil Solutions over either the porcelain or the Berkefield filter is briefly discussed in "American Export Monthly," Sept. issue—page 46.

Among the recent developments of the Cincinnati Precision Lathe Co., Cincinnati, O., are a universal or swivel-head lathe and a combination internal and external tool post grinding attachment. Described in Iron Age, Oct. 3rd, 1912—page 820.



Special Exhibit of Norton Products arranged for the benefit of Delegates of the Fifth International Congress of Chambers of Commerce who visited the Norton plant on September 30th. Many nations of the World were represented among the visitors and we appreciate the honor of their visit

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

NOVEMBER

1912



A Battery of Norton Plain Grinding Machines in the plant of The Overland Company, Indianapolis, Ind., for grinding Crankshafts and Cam Shafts, and a group picture of the operators. This class of operators was given a special course of instruction in grinding by one of Norton Grinding Company's demonstrators and the company has profited by reason of their wisdom in selecting an intelligent class of help and giving them the proper instruction.

GRITS AND GRINDS

Vol. IV

November, 1912

No. 7

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Room for Chips

By C. H. Norton

When selecting a wheel or adopting a method of grinding, it is necessary to consider the question of room for the chips removed by grinding.

Grinding with Cup Wheel

When grinding with a cup or ring wheel, it is necessary that the work be of such form that the chips can escape. The grinding of a continuous flat surface with a cup wheel is not successful because the chips removed are confined between the wheel face and the work surface.

In some cases where the surfaces are not too large, success is gained by very rapid work speed and very shallow cuts with relatively coarse wheels. This to make very small chips that they may not fill the spaces between the cutting points of the wheel. Generally, however, grinding of continuous flat surfaces with ring or cup wheels, is very difficult and the results unsatisfactory.

In cases where the surfaces ground are not broad, the ring or cup wheel is very successful when care is taken to secure exactly the right grade and grain for each case.

One maker of grinding machines using the disc wheel advocates reducing the area when designing all flat work in order to enable his side wheel machines to give good results.

Grinding with the Periphery

When using the periphery of the grinding wheel, the line of contact can be so

small that chips cannot be confined between the wheel and work whether the cutting face be narrow or wide; therefore, with the same width of wheel face in each case we can cut more deeply with the periphery than with the side because the chips are not confined. It is the confinement of chips that prevents us from using the grinding wheel as we do the milling cutter, viz., a slow work traverse and very deep cut of wheel.

Deep milling cuts were not possible until milling cutters were made with very coarse teeth to allow room for the chips. We should, therefore, when deciding upon a method of grinding and when selecting a wheel, remember that the more and larger the chips we remove, the more room we must provide for them.

It has been figured out that in some cases there are as many as two billion cutting points on the face of a grinding wheel at work each minute; eight hundred million per minute is not uncommon and four hundred million per minute is very common.

When the grinding wheel is revolving at a cutting speed of about 6,000 surface feet per minute, it will be readily seen why in some cases it can remove metal more quickly than the milling cutter or lathe tool. It is also apparent that the character of the abrasive material used in the wheel is an important factor as well as the grain and grade.

Manufacture of Norton Silicate Wheels

Every Step Standardized—Preparation of Material Important—Tamping an Art—Reason for Silicate Wheels—Advantages of Their Use under Certain Conditions—Operations on which They are Generally Used.

By Ross C. Purdy.

It is a simple matter to make a silicate wheel; in fact, so simple that it is in a few instances a "home industry." All that is needed is the abrasive, the bonding materials, muscle enough to tamp the mixture into the shape of a wheel and a good red-hot cook stove. It should not be inferred from this, however, that it is at all easy to consistently make good silicate wheels or to duplicate wheels having the same cutting and finishing efficiency unless every detail of the process has been standardized.

Norton Company make silicate wheels in just the same way as any one else would do with the exception that they are using specially designed machines and have so standardized every step of the process and every material which is used, that each silicate wheel produced by them is an insurance policy within itself. If the wheel comes up to the fixed standard adopted for that particular wheel, it is sent out with the assurance that within limits of probabilities it will do the same work with exactly the same efficiency as the wheel of same size, grit and grain had done before.

Norton Company purchases on specifications which cover both the chemical and physical properties of the materials. No box, barrel or sack is opened by the operating department until it has been stamped with an O. K. by the research laboratory and the invoice accepted.

Standard size batches of the mixtures are always prepared in a prescribed manner, giving to each step a specified length of time. No time or power is spared in thoroughly mixing the materials, giving to each just that correct combination of "stickiness" and granular condition that is required for tamping the wheel to a

uniform density, so that the wheel itself is not only uniform in density throughout its entire mass but also uniform with all other wheels of the same kind.

To appreciate how important is the preparation of the material for tamping, one need only to make a few wheels to know that large differences in grade may be produced by the manner in which the material will pack into the mold and hence the preparation of the material for tamping requires close adherence to standard methods.

The tamping of these wheels is an art that few can master or in which they are willing to persevere until they have it mastered, for to give each wheel just the amount of tamping required to produce a given grade takes brawn as well as skill. The wheel which is tamped at 5 P. M. must be just the same as one which was tamped at 7 A. M.

Then, after the material in the wheel has been put into the required shape and density, it must be burned. The wheel must not only be rendered hard and tough, but it must be insoluble in water, *i. e.*, waterproof. Here, also, to obtain uniform results nothing can be left to guesswork or possible fickleness in judgment. Each wheel must be heated in an oven, coal fired, as near as possible up to a given temperature, at a given rate. The proper time-temperature treatment of silicate wheels is quite important, for over burning is as damaging as under burning and the allowable limits of variation are narrow.

When burned and cooled, the wheels are then trued, graded, balanced, bushed, tested and inspected in the same careful manner as all the Norton wheels.



Making Silicate Wheels

Why are Silicate Wheels Made?

In contrast with the vitrified, there are not very many silicate wheels used, but for the few that are used there are good and sufficient reasons not creditable to prejudice. In those grinding operations where they must have the lowest wheel wear compatible with cool cutting, silicate wheels have some advantages. In cases of large wheels, which because of manufacturing difficulties would be altogether too costly, silicate wheels find a useful and increasingly large field.

The following list gives some of the grinding operations in which the silicate wheels have been found to be especially adapted due principally to the low wheel wear consistent with cool cutting. It should be noted that these cases, when summed up, indicate that silicate wheels are quite well adapted to tool grinding in machine shops.

Use of Silicate Wheels

For grinding high speed steel machine shop tools, such as reamers, milling cutters and the like: It has been found that an Alundum silicate wheel will grind

these tools very much cooler than a vitrified wheel, besides producing a very keen cutting edge.

Hand grinding lathe and planer tools: Silicate wheels for this work are preferred by most operators as they claim to be able to obtain a more satisfactory edge than with vitrified wheels. These wheels are used wet.

Pratt and Whitney, and Blanchard Cylinders: For wheels such as these, the silicate process has been found the most satisfactory, as silicate wheels seem to allow a wider variation in grain and grade than vitrified wheels.

Dish-shaped wheels: Dish-shaped wheels such as Brown & Sharpe No. 60 are usually made by the silicate process as the class of work on which these wheels are used demands a cool-cutting wheel.

Wheels larger than 36" in diameter are made by the silicate process due to the manufacturing difficulties encountered with vitrified wheels of this size and larger.

Wheels containing a wire web: Some customers demand a wire web in their wheels as they think it makes them safer, and such wheels are made by the silicate process.

First Aid

How Accidents are Treated in the Norton Works—Physical Examination of Employees—First Aid Routine in Case of Accident—Details of Treatment—Eye Protection and Treatment of Eye Accidents.

By Dr. W. Irving Clark

The method of treatment of accidents in a large shop is a matter of the greatest importance; first, because of expense to the company and second, because of moral effect.

Every accident occurring produces a certain amount of confusion in the shop, an expense from the time lost by the injured man and an expense from compensation paid to the injured man. A series of accidents in one part of the shop, if the accidents are severe or the treatment poor, may produce demoralization of the department.

The Norton Company considers accidents also from the side of the employee, feeling a strong moral obligation not only to prevent all preventable accidents, but to give prompt and efficient attention to any employee who receives any injury great or small.

Owing to the Norton system of making a complete physical examination on every employee, the Medical Department is able to advise the company when an employee is found to have a defect which renders him liable to injury in the work he is doing. Thus, if a man is found to have a weak heart and to be working near dangerous machinery, or in a hot room near a furnace, the company moves him from this dangerous work and puts him in a department where a sudden dizziness may not cause his injury or possibly his death.

Another great advantage of the physical examination is that it enables the doctor to know the exact condition of a man previous to an accident. Thus, a recent case occurred in which a man after lifting a heavy wheel went to the hospital complaining of severe pain in the groin. Examination showed a small rupture. On looking up the man's record, it was found

that he had no rupture when examined a month before and that, therefore, his injury had just been incurred and entitled him to compensation. The same rule works in the opposite way when a man claims to have received an injury which upon consulting our records we find he previously showed at physical examination.

It is essential in the case of an accident occurring in any department that there be some person present who has some knowledge of first aid, and who will see that the injured man receives prompt attention and is conveyed to the shop hospital at once. This work is detailed to the foreman in each department. The foremen were first called together and a series of lectures given in which the more common types of serious injuries were described and discussed, and their immediate treatment outlined. The subjects lectured on included sprains, fractures, dislocations, abrasions, contusions, lacerations, hemorrhages, burns and electric shock.

After the lectures, the foremen were invited to ask questions, and all matters in which there was any misconception was thoroughly explained. After the lectures were completed, the foremen were examined and given a series of practical tests in bandaging, applying the tourniquet, and splinting arms and legs.

Each department is supplied with a first aid jar containing all the equipment necessary for prompt treating of serious accidents. These jars are air tight so that the goods keep well. It can be readily seen that the equipment is complete and they can be used to carry water in an emergency. They are regularly inspected by the hospital nurse and are kept hanging in a conspicuous place in each department



Cleansing the Wound

Each jar bears a label with a few words of instruction and further cards of instruction are posted near the foreman's desk in each department. When an accident occurs, the following routine is followed:

- 1st—If the accident is severe the foreman renders first aid and notifies the hospital nurse who brings stretcher to patient and replaces foreman as man in charge of the case.
- 2nd—Patient is immediately conveyed to shop hospital under nurse's care and the doctor notified.
- 3rd—Patient is prepared for doctor's treatment.
- 4th—Doctor arrives and treats patient.
- 5th—Patient is conveyed to hospital or home (by ambulance—city).

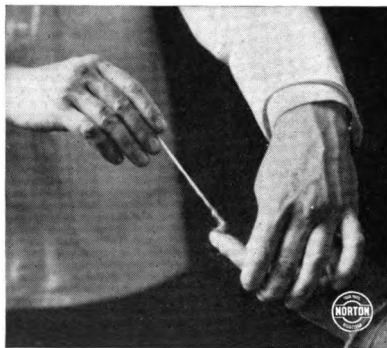
Most of the accidents, however, are not serious and the man in such a case notifies his foreman and goes direct to the hospital where the nurse treats him, and he in turn, in most cases, returns to work. If the doctor is in the hospital at the time of the accident, he naturally takes full care of the case and all injured men see the doctor on his next visit to the hospital.

Such is the general routine adopted and it has been found to work admirably.

The minor details of treatment, however, are of some interest and we will here give a few of our methods.

LACERATED WOUNDS.—These form the bulk of the accident work and vary from slight cuts of the fingers to severe injuries of the hands. The old method of treating these injuries was to scrub them with soap and water for five minutes using a sterile nail brush, then to wash them in bichloride of mercury for two minutes and then wash off with sterile water. This method was effective, but painful; besides this, it had the disadvantage of sometimes killing already partly devitalized tissues and in some cases requiring an anæsthetic before it was possible to clean thoroughly without unbearable pain. For the last nine months we have been using the gasoline and iodine method of cleansing and since its adoption have not had a single case of infected wound.

The method is as follows: the injured part is thoroughly washed in gasoline, with gauze, thus removing rapidly all dirt and grease. The wound and surrounding parts having thus been cleansed the wound and adjacent skin are painted with two or more coats of Tr. of Iodine U. S. P. The wound is then sutured or dressed as the surgeon sees fit. Next to the wound, we always apply a compress of sterile gauze (dry) and hold the dressing in place with a bandage. The bandage is rendered more secure by narrow strips of



Painting with Tr. Iodine



Applying the Cross Piece of Tin

adhesive plaster wound spirally over it. We have never had a bandage loosen or come off even though the man went directly to work, and this we consider is due to the adhesive plaster.

Injuries to the finger tips are common and are frequently very troublesome owing to the frequent knocks they receive. To obviate this difficulty, we have adopted the cross piece of tin shown in the cut which was described recently in the *Journal of the A. M. A.* This simple device has given great relief in many cases.

All cases of fracture are carefully splinted and then sent to an X-ray expert for a picture. By this means, we are able to know at once if the setting is not accurate and readjust the same.

It must be remembered that the Norton treatment not only includes first aid but subsequent dressings until the patient is able to return to work.

If a man is so severely injured that he is unable to come to the shop hospital for dressing, the doctor visits him at his home and treats him there until he is able to come to the factory for treatment.

The appreciation of the men is evidenced by the number of small injuries coming to the shop hospital for treatment and by the fact that no injury now occurs in which the patient does not seek the hospital before going home or continuing work.

Owing to the nature of the work, there are many cases of foreign body in the eye. These vary from small pieces of Alundum to good sized splinters of steel. It is almost impossible to protect the eyes of the workers. Although the factory provides goggles free to all desiring them and advocates their use, the weight and heat added to the obscured vision render them objectionable to the majority of the men.

The chief objection to the goggle is that the inner or eye side of the glass becomes steamed and that the fine dust with which the air is filled collects in this steamed surface next to the eye. The result is absolute blocking of vision until the glass is removed and cleaned, which is a troublesome operation.

Most of the foreign bodies in the eye if seen at once can be readily removed by wiping the eye with gauze or cotton. We do not have to use cocaine for this. Following the removal of the foreign body the eye is well irrigated with 2% boric acid solution and then three or four drops of 10% argyrol instilled, in order to disinfect the cavity left by the foreign body. When the piece of steel or abrasive cannot be removed by these simple means, the man is sent at once to an expert oculist for operative removal of the offending particle.

Full records are kept of each accident case, and the type and number of machine causing the injury is sent to the Safety Committee so that a guard or other appliance may be devised when this is possible.

By these methods the Medical Department has converted every wound into a clean one and has kept the time of recovery minimal, thus increasing the good feeling between the men and the company.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Special Internal Grinding Machine designed and constructed by J. Parkinson & Son, Shipley, England, is described in European edition of American Machinist, Sept. 7th, 1912—page 30E. Designed for grinding parallel and taper holes in the spindles of lathes, millers, gear-cutters, etc., but it may be used for ordinary internal grinding. Floor space 13' by 3' 6".

"The Planer as an Internal Grinder." Illustrating how a planer may be converted into an internal grinder for handling large work. American Machinist, Sept. 26th, 1912—page 531.

Belt Surface Grinder. The Peerless Surface Machine Co., Newark, N. J., has recently developed a line of horizontal and vertical belt surface grinding machines. American Machinist, Sept. 26th, 1912—page 539.

"Fallacies About Cylindrical Grinding," by C. H. Norton. Southern Machinery, Sept. 1912—page 178.

"The Safeguarding of Grinding Wheels" by F. B. Jacobs, Industrial Engineering and Engineering Digest, Sept. 1912.

"Commercial Grinding," by F. B. Jacobs. Article gives a few practical examples from actual work. Machinery, Oct., 1912—page, 127.

"Method of Grinding Small Double Angle End Mills," by Milton C. Taylor. Machinery, Oct., 1912—page 132.

A very accurate fixture for the square grinding of valve push-rods is shown in Machinery, Oct., 1912—page 135.

J. J. Guest & Co., Ltd., Coventry, England, are manufacturing a plain grinding machine of the travelling table type, 7" swing by 20" between centers.

European edition American Machinist, Oct. 26th, 1912—page 109.

Harper Sons & Bean, Ltd., Dudley, England, describe a new water tool grinder in which the spindle motion is controlled by a clutch. European edition American Machinist, Oct. 19th, 1912—page 91E.

A method of grinding the outside of threading dies is shown in Oct. 1912 edition of Machinery—page 136.

The Cincinnati Precision Lathe Co., Cincinnati, Ohio, have just developed a friction-driven swivel-head lathe equipped with a combination external and internal tool-post grinder, making the machine a universal precision grinder and lathe. Machinery, Oct., 1912—page 146.

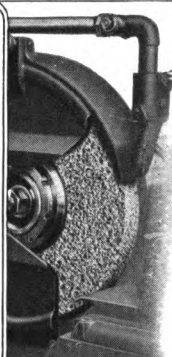
W. W. Blakely, Detroit, Mich., has designed a lathe tool grinder which eliminates the necessity of leaving the lathe in order to grind the tools being used. The wheel spindle is driven by frictional contact with the lathe cone. American Machinist, Oct. 24th, 1912—page 707.

A home-made grinding wheel attachment for sharpening the knives on a 92" Union Splitting Machine is described in Oct. issue of Southern Machinery—page 231.

The Churchill Machine Tool Co., Ltd., Manchester, England, are making a 6" x 84" Self-contained Plain Grinder mounting a Norton grinding wheel 26 x 3 x 8". European edition American Machinist, Oct. 12th, 1912—page 75E. They are also making a large Universal Grinding Machine, 20 x 60", embodying all the movements of the smaller machines and carrying a 16 x 2" Norton Alundum Grinding Wheel. Described in European edition American Machinist, Oct. 12th, 1912—page 78E.



GRITS and GRINDS



A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1912

DECEMBER

1912



Many grinding wheel users prefer a small catalog. This pocket edition is a reproduction of our large catalog and contains a lot of valuable information, rules, tables, wheel illustrations, etc. Every user of grinding wheels will find it convenient and valuable—it is well worth writing for.

GRITS AND GRINDS

Vol. IV

December, 1912

No. 8

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Technical and Trade Publications are privileged to reprint any information from GRITS AND GRINDS, if proper credit is given

Production is Increased by Making Provision for Chips to Escape

The following article by Mr. F. N. Gardner is interesting in that it shows what can be accomplished by grinding, if the work to be ground is designed in such a way as to allow room for the escape of grinding chips. While this is true of flat surface grinding such as is illustrated in this article as affecting the clearance for grinding chips, proper design can also make great savings in combination with grinding on cylindrical work as well. It also reminds us that very few seem to understand that some of the greatest savings by grinding are accomplished, not directly by the grinding machine, but by the preparation of the work for grinding.

Work in the following article is intended to be ground on the side of a wheel or disk. In such a case it is very important that there should be some provision for chips, as otherwise they would be confined between the grinding disk and the work, causing heating and glazing of the disk. When the periphery of the grinding wheel is used for grinding flat surfaces, there is little opportunity for chips to be confined between the wheel and work, except when very deep cuts are taken, thereby increasing the arc of contact. In all cases the size of grain and the grade of bond should be such as to allow all the room possible for chips between the cutting points.

In this connection it may be well to call attention again to the fact that some of the smoothest surfaces are made by

very coarse wheels and some of the roughest surfaces are made by fine wheels, for the reason that with the fine wheels the chips are confined between the cutting particles and cause scratches in the work. This is especially true with flat disk grinding or ring wheel grinding.

The designs shown in this article provide room for chips and thereby increase production with any given grain and grade of wheel.

There is no doubt there are opportunities in almost all industries for great savings, provided some thought is given to these points,—of the form of the work, grain and grade of wheel. Whether it shall be disk wheel, ring wheel or periphery wheel, they all have their place, but no one of them is a panacea for all ills and each case should be considered upon its own merits.

We congratulate Mr. Gardner for his clear presentation of one of these very important facts in connection with grinding.

Hundreds of examples might be cited in every branch of commercial activity to show that the many articles with which we daily come in contact and which we accept as a common every-day occurrence are the direct result of careful research work and scientific study. This applies very emphatically to the manufacture of grinding wheels. Science, practically applied, in the art of wheel making is comparatively young and yet has achieved much.

Reducing Surface Area for Disk Grinding

By F. N. Gardner*

That it is often possible by the use of a disk grinder to produce parts accurately machine-finished for less than the present cost of the rough castings is a paradox, and I shall attempt to prove its truth. It is obvious that whatever saving there is must be made in the weight of the casting. Castings that are to be finished by disk grinding always can be, usually ought to be, and sometimes must be, considerably lightened before machining them with a disk wheel. First, when patterns are made so as to leave $\frac{1}{8}$ inch to $\frac{3}{16}$ inch of metal for "finish" with a planer, milling machine, lathe, etc., 50 to 90 per cent. of that surplus metal can be saved. Second, flat surfaces that are to be finished by disk grinding can, more frequently than not, have a portion of their area depressed or sunk from $\frac{1}{16}$ inch to $\frac{1}{8}$ inch or more below the finished level.

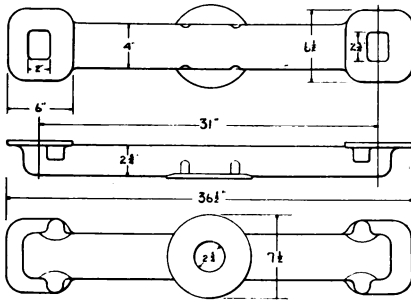


Fig. 1

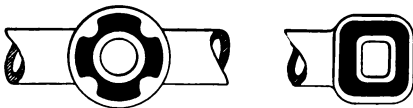


Fig. 2

Figs. 1 and 2 show views of a piece that has a large flange in the center and smaller flanges at each end, facing the opposite way. It is required to grind these flanges to a finished and true sur-

face. As originally made about $\frac{1}{16}$ inch in thickness of metal was left on these flanges to be removed by planing. I recommended cutting this down to $\frac{1}{32}$ inch, and also depressing the surface about $\frac{1}{8}$ inch below the required finish line as

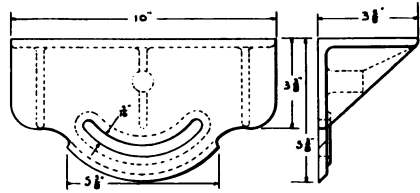


Fig. 3



Fig. 4

shown in black, the black representing the depressed area. By this means the original weight of 55 pounds is reduced to $49\frac{1}{2}$ pounds, showing a saving of about $5\frac{1}{2}$ pounds of cast iron which would mean saving 14 to 15 cents on each casting. And with the area to be ground reduced—by forming the depression shown in black—from 102 square inches to 63 square inches or nearly 40 per cent., these pieces can be disk ground at a cost not to exceed 10 cents each, making the finished piece cost less than did the rough castings as originally made. This was a case where the casting "must be lightened" to make it a disk-grinder job.

Figs. 3 and 4 show a small angle plate. This is not a case where the finished pieces cost less than the ordinary rough casting, because the piece is light and the saving in weight from depressing that part of the surface as shown in black on Fig. 4, although of some account, is

* President, Gardner Machine Company. Reprint from American Machinist.

quite small as compared to the amount of work to be done. The essential object in lightening this casting is to reduce the area of surface to be ground. Fig. 3 shows the piece as it would ordinarily be made for machining with a shaper or milling machine. Made in this way the large surface has an area of about 38 square inches. I make them as shown in Fig. 4, with 26 square inches of this area depressed $\frac{1}{16}$ inch below the finish line, leaving only 12 square inches to be surfaced, which means that by depressing a part of the surface that would otherwise have to be ground, a little cast iron was saved and the amount of grinding was reduced more than three to one. As a matter of fact, it makes the finishing of the surface a cheap and very satisfactory job when to disk grind the entire surface as shown in Fig. 3 would be almost impracticable on account of the thinness of the casting in proportion to the area of surface to be ground.

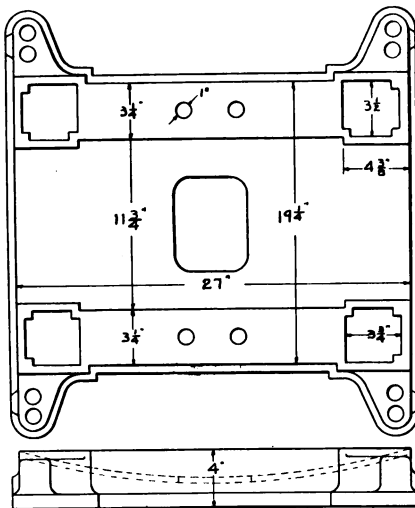


Fig. 5

Figs. 5 and 6 show another case in which the pattern must be changed if the casting is to be disk ground. The surfaces requiring finish as at present cast have a total area of 155 square inches. If part of this surface is depressed below the finish line, as shown at Fig. 6,

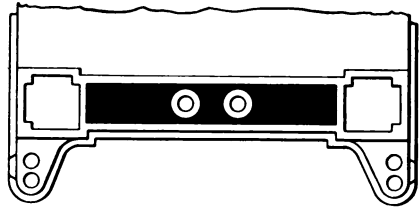


Fig. 6

this area will be reduced to 90 square inches. The weight of the casting will be reduced about eight pounds, and while that may not quite offset the cost of disk grinding, it will make such grinding practicable and probably cheaper than any other method.

On vertical-spindle disk grinders the work is fed to, or forced against the disk by gravity pressure. When cast iron is being disk-ground it should be forced against the disk with a pressure equaling at least five pounds to the square inch of surface and from that up to 35 or 40 pounds. Any pressure less than five pounds to the square inch makes slow grinding. Now the casting shown in Fig. 5 weighs 158 pounds, which gives about one pound per inch. To get fairly good cutting efficiency from the disk, 600 pounds of extra weight would have to be put onto the casting while it was being ground, making a total of over 750 pounds bearing on the disk wheel—which is plenty, if not too much. On the other hand, if this surface area is reduced, as shown in Fig. 6, a total weight of 450 pounds will give quicker and better results.

Figs. 7 and 8 show a casting for a squaring gage used on the plain tables of our disk grinders. The depression shown in the surface in Fig. 8 makes it possible and easy to disk-grind these long, thin castings accurately straight and flat. Without the depression the surface to be ground would contain 15 square inches. With the depression it is only eight square inches. Without the depressions the heat generated by grinding would warp the casting and make it difficult to get them straight; with the de-

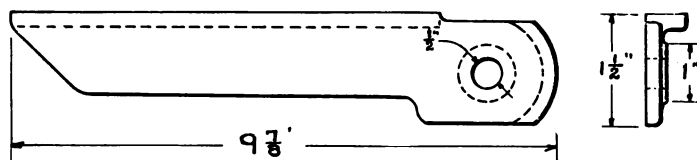


Fig. 7

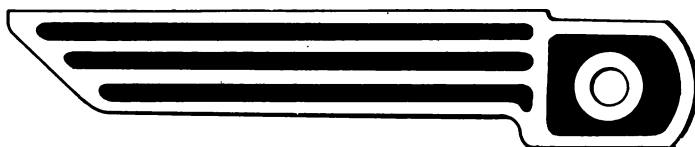


Fig. 8

pressions the heat causes very little trouble and it is easy to get them straight.

I have often said, and it will bear saying again and again, that the place to start profitable and efficient disk grinding practice is in the drafting room. Make your pattern drawings so that the castings to be disk ground will have the least possible stock left for "finish" and the

least possible area of surface to grind to a finish. In this way you will save on three important items: The weight of the castings; the cost of finishing them; and on the life of abrasive disks. The extra first cost of making your patterns in this way is so small that it is hardly noticeable and the saving stays with you for the entire life of the pattern.

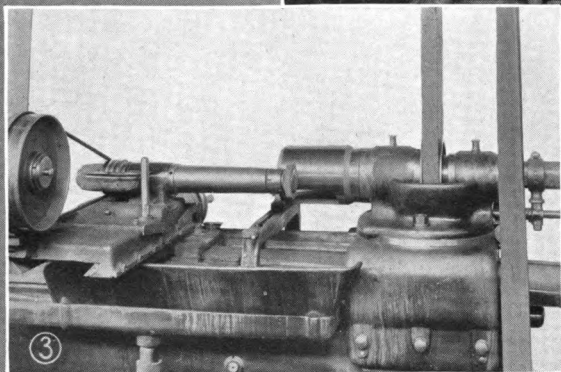
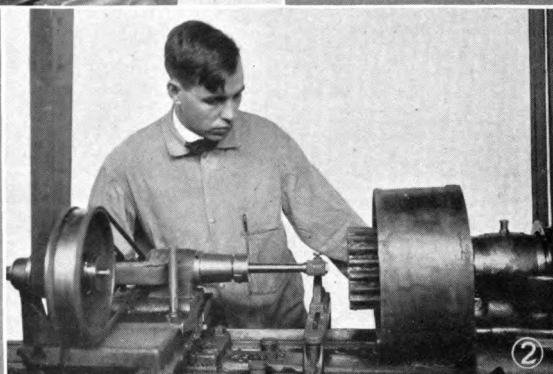
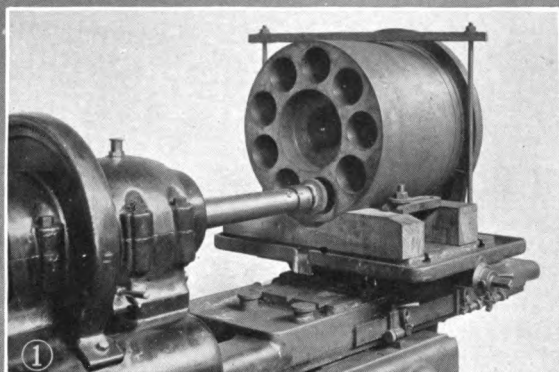
A little oxygen and a difference in structure of the grain causes the well known but remarkable contrast between the soft aluminum metal and the very hard Alundum. As parallels to this, it is recalled that structure is the only cause for the difference between graphite, a lubricant and diamond, an abrasive, and that a small quantity of soft carbon added to pure iron, which by itself is very soft, converts it into hard steel.

It is a knowledge of the many little unexpected and unexplainable affecting factors like these that enables the Norton Company to maintain a constancy in cutting efficiency in their Alundum Wheels. While it is but one or two variants that cause the difference in character of the materials already referred to, there are many which must be considered when making an efficient wheel. Two or three varying factors are easily kept under control, but when they are so many

in number, as in the case of abrasive wheels, as to make it almost impossible to distinguish the causes from the effects the problem becomes one not only of discovery but of constant investigation to keep the beneficial factors so strong as to overbalance those which are damaging.

The trite expression—"Little acorns to large oaks grow" is dwarfed in meaning by the more modern one—"Apparently small causes big effects make."

That the Norton Company is seriously attempting to get an understanding and control of the things that go to make high cutting efficiency is shown by the fact that they have one of the best equipped industrial research laboratories in the country. Their efforts in this direction are very largely successful and it is assured that nothing short of the highest proficiency and maximum efficiency will satisfy them.



- (1) Hole Grinding in Cast Iron Cylinder with a Crystolon Wheel.
- (2) Grinding Manganese Steel Pinion with an Alundum Wheel.
- (3) External Grinding on an Internal Grinding Machine. Material Cast Iron. The same wheel is being used on the outside and inside the 4-1/2" hole. The grinding wheel used is made of Crystolon.

Illustrations by courtesy of Heald Machine Co., Worcester, Mass.

Suggestions on Paper Knife Grinding

In all knife grinding, a rigid well-designed machine and a modern grinding wheel of the right grain and grade are of first importance. Heavy knives in particular cannot be ground with perfect accuracy on a machine so light that it cannot do its work without vibration.

SHAPE OF BEVEL. The degree of the bevel of a knife is frequently varied to suit local conditions. The shape or angle of the bevel is a very important consideration. Generally speaking, the angle should be 26 degrees which is equivalent to a straight bevel of $1\frac{1}{8}$ " long on a $\frac{1}{2}$ " knife. If the knife is thinner, of course the bevel will be shorter, and longer on a thicker knife. It is desirable to avoid getting too long a bevel with a consequent thin edge. Too much concaving of the bevel should also be avoided. A concave bevel has a tendency to weaken the cutting edge. If a knife is too heavy for the work, it is sometimes advisable to make a very short second bevel with a hand stone on the knife's edge, changing the angle to about 40 degrees for a distance of $\frac{1}{8}$ ". This second bevel will support the cutting edge and save considerable grinding; but the difficulty in cutting will be increased and the second bevel should be resorted to only when the paper is extremely hard or gritty.

METHOD OF SHARPENING. The grinding wheel should be what is commonly termed a free cutting wheel and of such a grit and grade as to reduce the tendency to glaze to a minimum. The face of the wheel should be kept sharp and true. The general practice is to grind wet and the speed of the wheel should be right to commensurate with other conditions. The knife should be applied to the wheel so that the cutting will be against the edge; in other words, the motion of the wheel is from the cutting edge toward the body of the knife. This method insures a constant supply of water on the edge of the knife where it is most needed. It is impossible to grind the knife without im-

pairment of temper if the face of the wheel is glazed. A glazed place in a wheel generates heat rapidly, due to the fact that the wheel rubs without cutting, and the edge of the knife cannot be kept sufficiently cool by water to prevent drawing the temper. A wheel that continues to glaze after it has been re-dressed or sharpened is either too hard or too fine for the work.

To remove the glaze from the face of a wheel, a Crystolon stone or metal disc dresser should be used. Do not continue to grind a knife with a wheel that glazes, but get one of another combination of grain and grade. Wheel cost is much less than knife cost and it is not economical to grind knives with the wrong wheel.

FEED. The feed should not be too heavy. The depth of cut is essential and should be very carefully regulated. If the machine runs with automatic feed it should be so timed and adjusted that there will be no likelihood of drawing the temper, and the operator should watch the edge of the bevel to see that the temper is not drawn by excessive heat due to forcing the grinding wheel. It is well to remember that with a heavy feed and a wheel with the wrong combination of grain and grade, it is easy to draw temper no matter what kind or make of wheel it is. The knife should be hand honed after removing from the grinding machine, using a quick-cutting stone and kerosene as a lubricant. The honing should be carefully and skillfully done toward the edge with no honing on the flat side of the knife. A feather edge can be readily removed with a pine stick. Do not continue to use a grinding wheel after it has been worn so small that the concave of the bevel is noticeable. A concave bevel made by too small a wheel makes more frequent grinding necessary, reducing the knife faster in width and impairing the cutting qualities of the knife. Cutting with a concave bevel is equivalent to the use of a razor

for whittling—it will cut while it is sharp, but you cannot push on it. The concave edge will waver in a heavy lift, sometimes springing $\frac{1}{2}$ " out of true, before the cutting is completed. The edge is not strong enough to stand the pressure put upon it.

NICKING. A manufacturer of knives is authority for the statement that 98% of the complaints about nicked or rough edges are due to improper grinding and the balance are evenly divided between unsecure fastening, too heavy lifts and flaws in the cutting edge. The so-called "nicking" is generally due to the drawing of temper at the extreme edge of the

knife by improper grinding. It can be cured by grinding off the edge until the softened places have been cut out and then re-bevel the knife. The way to overcome nicking is to follow the foregoing suggestions about the use of the right wheel, water, proper speed and feeds.

WHEELS. The grinding wheels generally used for paper and planer knives on automatic machines are 30 to 46, J to K Alundum. Hand grinding, 46 to 80, J to M Alundum. These wheels usually meet all requirements when wheels are used under the proper conditions as related to speeds and feeds.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A method used to grind the staffs of Ames gages is shown in the Nov. 7th, 1912 issue American Machinist,—page 772.

The St. Louis Machine Tool Co., St. Louis, Mo., has recently developed a grinder with self-contained countershaft, especially designed to impart a smoother motion to the wheels by having the belt strain down against the body of the machine. American Machinist, Nov. 7th, 1912—page 789.

The Northampton Emery Wheel Co., Leeds, Mass., has brought out a high speed motor-driven buffing lathe designed for rapid and accurate buffing and polishing work.

In November 1912 issue of Machinery, the manufacture of New Departure ball bearings is described. Grinding plays an important part in the finishing of these bearings and cuts are shown of various grinders. Methods of grinding are described. Page 168.

A machine for hob sharpening and worm grinding built by J. Holroyd & Co., Ltd., Milnrow, England, is described in Euro-

pean edition American Machinist, Nov. 12th, 1912—page 116E.

A 12" x 72" plain grinding machine with traveling wheel head, carrying a 20 x 2½" wheel is being made by Greenwood & Batley, Leeds, England. European edition American Machinist, Nov. 2nd, 1912—page 117E.

The Brown & Sharpe Mfg. Co., Providence, R. I., has published a 40-page book entitled "Points about Grinding Wheels and their Selection" which contains desirable information for the operator of grinding machines as well as information for the buyer of machines and wheels.

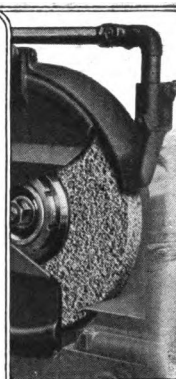
The Peerless Surface Machine Co., Newark, N. J., has recently brought out a line of belt-driven surface grinding machines which are built in both the vertical and horizontal types. Iron Age, Oct. 24th, 1912—page 1008.

Face Plate for a Grinder. A face-plate designed for holding such work as round drawing dies, cutters, etc., in a Norton Universal Grinding Machine, No. 1, is described in American Machinist, Nov. 14th, 1912—page 813.



GRITS and GRINDS

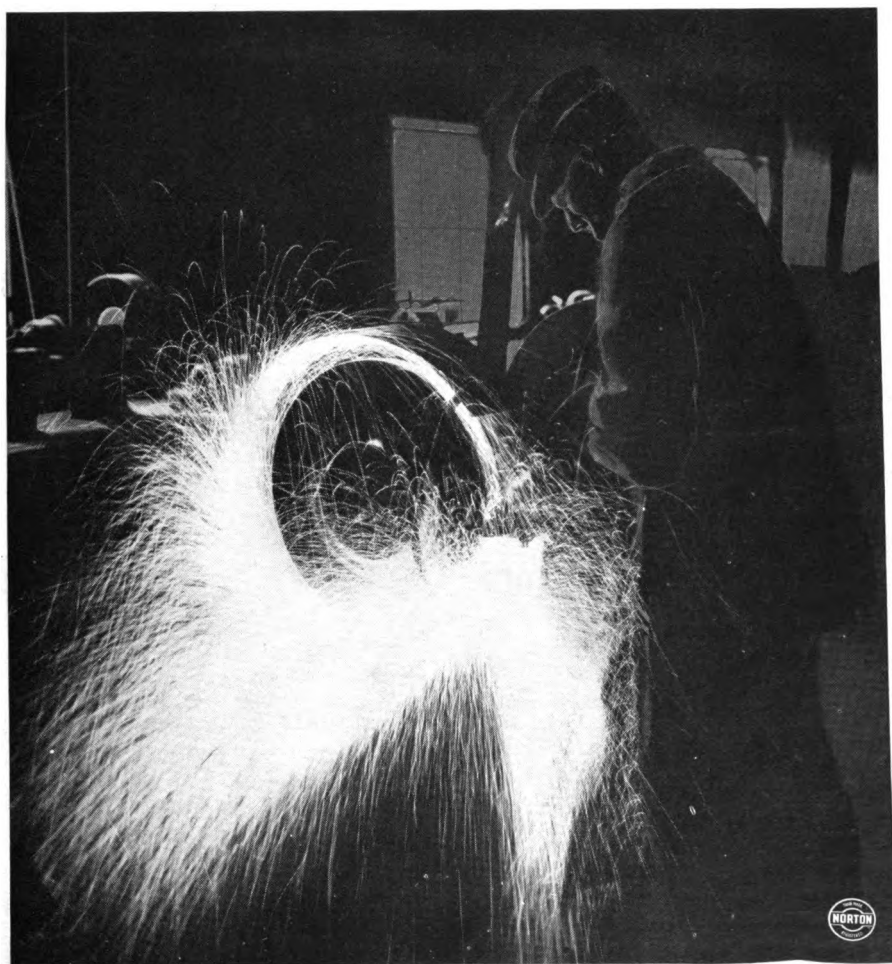
A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.



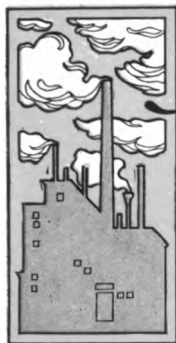
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FEBRUARY

1913



Spark Test made under Conditions that Enable the Camera to Vividly Portray its Brilliancy



GRITS and GRINDS

Vol. IV

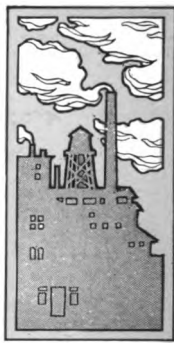
February, 1913

No. 10

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Grinding Wheel Sparks

By R. G. WILLIAMS

Mechanical Division, Norton Research Laboratories

[The writer acknowledges his indebtedness to Mr. Jno. F. Keller, instructor in forging and heat treatment of metals, Purdue University, for the inspiration that led to the selection of this subject, for the spark diagram shown herewith and for much of the text used in describing the diagram. This article is a revision of a paper read at the Annual Sales Conference of the Norton Company, Jan. 7-10, 1913, at which time Mr. Keller's diagram was thrown on the screen and the characteristic of the various sparks were shown by actual demonstration.—Editor]

When certain kinds of metal, namely, iron and steels, are pressed against a rapidly revolving grinding wheel, sparks are produced. Sparks are pieces of metal which are torn away from the mass being ground, and during this tearing process are heated to such a high temperature that they become molten. In this highly heated condition they give out light, the amount of light produced being proportional to the temperature to which the metal is heated.

It is one of the natural laws of physics that when a liquid drops, or is thrown through the air, it takes a spherical form. Ordinary rain drops are an illustration of this fact. Consequently, we would expect the solidified sparks to be in the form of little solid globules. In a general way this is true, but not exactly. When these sparks first cool they do take on the form of globules, but as they get colder, the outside and solid shell contracts on the liquid interior until a point is reached where the pressure of the liquid interior is great enough to rupture the outside shell, and the phenomena, which we refer to as spurting or forking, then takes place. All that is left is part of a hollow spherical shell.

As far back as 1804, a Frenchman made some spark experiments with an old-fashioned grindstone, but it was probably not until the introduction of high speed steel that grinding wheel sparks became of interest to the ordinary shop-man. It was noticed that high speed steel did not spurt in the same manner as ordinary carbon steel, and this led to the question of what it was that produced different kinds of sparks. It is common knowledge that the air contains oxygen, and it is the combination at high temperatures of oxygen in the air and the constituents of the metal being ground that produces spark characteristics peculiar to different metals. Carbon is the most influential constituent, the volume and brightness of sparks being roughly proportional to the amount of carbon present in the steel. In other words, a high carbon steel gives a large volume of sparks; a medium carbon steel gives a moderate volume; and a very low carbon steel, or wrought iron, gives a still smaller volume. High speed, or self-hardening steel, as it is sometimes called, is in a class by itself, and the characteristics peculiar to this class of steels will be taken up later in this article.

Chips is the name used for these sparks



**Microphotograph of Chips Made by Wheel
Cutting Properly**

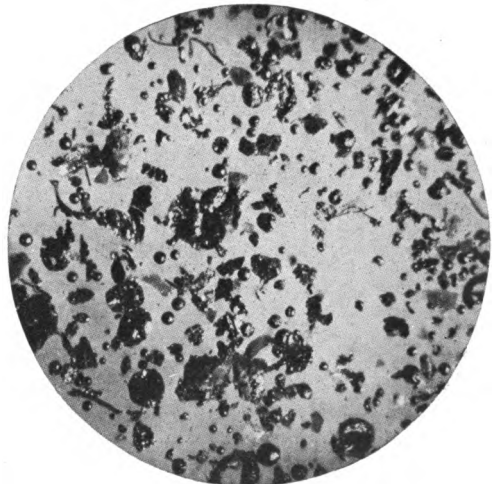
when they have become solidified, and by an examination of these chips through a magnifying glass it is possible to tell whether or not the wheel was cutting properly. A good many kinds of material, notably high carbon steel tools, require a very cool cutting wheel; that is, one which will generate very little heat during the grinding operation. This is necessary, for, if the wheel generated considerable heat, there would be great danger of drawing the temper of the tool and its usefulness being destroyed. If upon examining chips through a magnifying glass, we see a predominance of curls over globules, we say that the wheel is cutting properly and generating a very small amount of heat, but if the sample of chips shows a predominance of globules over curls, we then know that the wheel is generating more heat than it should.

Whether or not a wheel is cutting properly can also be judged by the volume of sparks produced during the grinding operation. If two wheels are working on the same kind of steel, and one wheel is only producing a small volume of sparks, while the other wheel is producing a large volume, it is an indication that the first wheel is

not cutting satisfactorily. The most common cause of a wheel not cutting satisfactorily is being in a state which those initiated into grinding wheel language know as glazed. When the minute cutting particles of a wheel, which should stick out far enough to penetrate the material being held against the wheel, have worn down flat, have lost their sharpness, and no longer penetrate as they should, the wheel is then in a glazed condition.

The Brown & Sharpe Manufacturing Company have determined that sparks will show from a cylindrical piece of work when the depth of cut is only five-millionths of an inch. This will give you a good idea of why the volume of sparks is a correct indication of how the wheel is cutting. For instance, if due to improper supply of cooling liquid, or for some other reason, a shaft being ground is expanding just a little more on one side than the other, which would cause the shaft to be out of round when finished, the volume of sparks produced will be greater from the side which is expanding than from the other side.

The cut shown is a reproduction of a chart used in Purdue University by John



**Microphotograph of Particles Showing Effect
of Heat**



F. Keller, Instructor in Forging, to bring to the pupils' attention the spark characteristics of different iron and steels, as a means of roughly determining what kind of iron or steel they are working with. While not strictly accurate, in that the sparks shown are free-hand drawings, nevertheless, it is both interesting and instructive.

Figure 1 gives an idea of the characteristics of sparks from wrought iron. Wrought iron is free from carbon and the sparks follow straight lines which become broader and more luminous until they reach their maximum size, then gradually diminish until they grow dark. Wrought iron is easily distinguished from iron which contains carbon, that is, steel, in that there are practically no sparks which spurt or fork. The sparks from wrought iron present an analogy to meteors, or shooting stars. Meteors are masses of iron practically free from carbon which have been traveling about in space and come in contact with the air which surrounds the earth. They are traveling at an enormous rate of speed and sufficient friction is set up between the meteor and the air to heat the meteor to a temperature where the iron it contains combines with the oxygen in the air. In other words the iron burns and this burning produces light.

Figure 2 shows the sparks from mild steel. This contains a low percentage of carbon which is evidenced by the appearance of a few sparks which spurt, otherwise the sparks are similar to those from wrought iron.

Figure 3 represents the sparks from tool steel and it will be noticed that the number of sparks which spurt are greater than from mild steel. Also, the number of sparks characteristic of wrought iron have diminished. The color of the sparks has also changed from a light straw to nearly white.

Figure 4 gives an idea of the sparks from high carbon steel. The characteristic iron spark is no longer present and practically all the sparks spurt, a great many respurting a number of times. It will be noticed that the distance the sparks travel away from the grinding wheel has also

diminished. In high carbon steels, the iron and carbon are in such form that they most readily combine with the oxygen in the air.

Figure 5 represents high speed steel sparks. Although high speed steels contain a fairly high percentage of carbon, the chromium and tungsten they usually contain has the function of holding the carbon in such a state that the sparks characteristic of ordinary tool steel are entirely absent.

The sparks follow a straight line similar to wrought iron sparks, but give very much less light and end abruptly in a chrome yellow, pear-shaped mass.

Figure 6 shows the sparks produced by a certain kind of manganese steel which contains very much less manganese than is present in the common manganese steel used in railroad frogs and switches. A characteristic of sparks from manganese steel is their intense brilliancy and white color.

Figure 7 shows the kind of sparks from the earlier grade of Mushett air hardening steel. These sparks are hardly luminous, being dark red in color, and although this steel contains about 2% of carbon, it shows none of the characteristic sparks obtained from a straight carbon steel containing the same amount of carbon.

Figure 8 represents sparks from a special brand of steel known as magnet steel. The color of these sparks is orange, the characteristics differing in the manner shown by the diagram.

These are not all the varieties of sparks capable of being produced from iron and steels, but should give the reader an idea of the most common varieties. The soft metals like brass, bronze and aluminum, do not give sparks, while cast iron gives a very short, dark red spark which ends in a spurt in all directions.

Practical use can be made of the spark test in a good many instances, notably by the tool maker who has to handle different kinds of steel. Should a carbon steel be given the heat treatment required by a high speed steel, it would be ruined; or should a high speed steel be given the heat treat-

SPARK METHOD — OF — SELECTING IRON AND STEELS

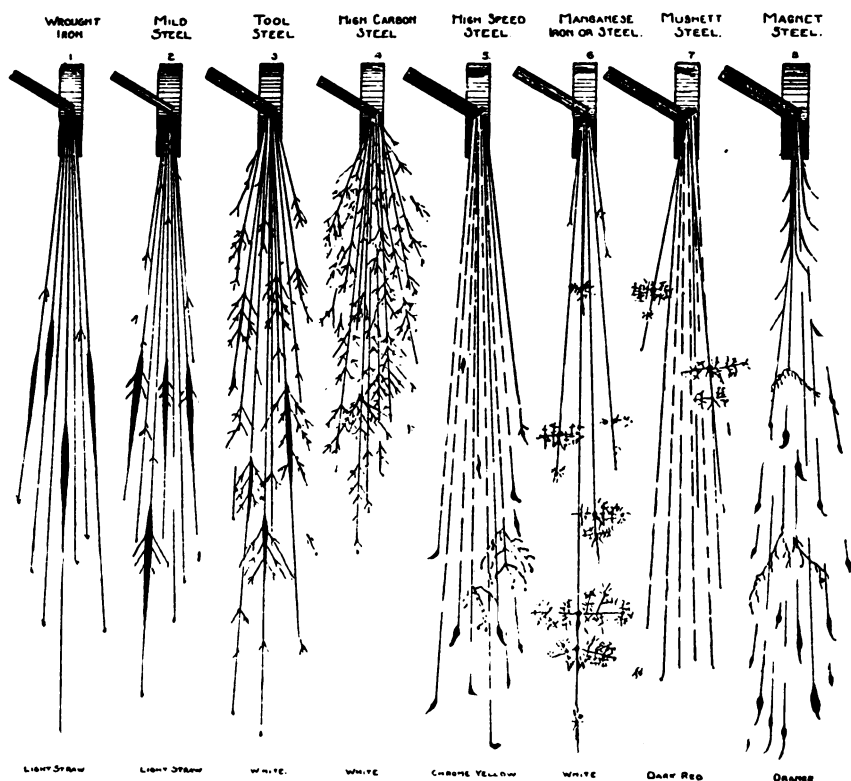


Chart Prepared by Jno. F. Keller to Show Spark Characteristics
Copyrighted, 1911, by Jno. F. Keller

ment proper for an ordinary carbon steel, it would not work at the highest efficiency. By using as standards steels of known

properties, one about which there is doubt can be readily correlated by means of a spark test.

Why a Wheel Appears Softer in the Center

Extract from a Paper Read Before the 1913 Norton Sales Conference
by H. W. H. Beth, Operating Engineer

There are two reasons why a wheel appears softer in the center.

The surface speed decreases in proportion to the diameter when the wheel wears smaller. If the surface speed decreases, the wheel will act softer and a larger quantity of abrasive is required to grind a certain quantity of materials.

For grinding a certain quantity of

material, a certain quantity of abrasive is worn off the wheels. Therefore, with decreasing diam., the thickness of layer worn off increases; in other words, wearing off the same quantity of abrasive will decrease the diam. faster when the diam. of the wheel is small than when it is large.

Uses of Alumina as an Abrasive and Refractory

By L. E. SAUNDERS*

World-wide Change from Natural to Artificial Abrasives — Possibility of Exact Duplication of Quality—Ability to Vary Characteristics—Value of Aluminous Refractories

Most of you undoubtedly consider Aluminum metal manufacture as the only significant factor in the consumption of Bauxite and other aluminous ores, and the refined product Alumina which we have just been hearing about.

I am therefore going to call your attention to another industry which places dependence on aluminous ores, the abrasive business.

Unless something calamitous happens to us during the next few months, this year will see a consumption of aluminous ores in the world corresponding to some ten thousand tons of aluminum metal, in the manufacture of grinding wheels. You may not realize to what extent abrasives enter in the equipment of the modern machine shop. Hardly an essential in our daily walks of life, but is dependent on this new machine tool for its manufacture. The breakfast food with which we start the day, the stove on which it is prepared, the morning paper which gives it flavor, the street car, railroad train or motor car which takes us to business, the marble panels in our palatial offices, the typewriters which write our letters, the pearl buttons on our gloves, the leather gloves themselves, nearly all our activities, and finally the polished granite columns at our graves would not be here in their present perfection were it not for the artificial abrasive which either makes an integral part or a machine to accomplish the end in view.

Broadly speaking, grinding is done in two classes—first, metals of high tensile strength such as steel of all classes, mallea-

ble iron, etc., and second, metals of low tensile strength such as cast iron, brass, aluminum, etc. As about 75% of the world's pig iron is converted into steel, and finished and wearing parts are largely made of this material, it may be seen that the first class covers the wider field. Aluminous artificial abrasives are used almost exclusively for this purpose and this fact offers a reason for the figures with which I started. The change from natural to artificial abrasives is world-wide, the use of emery and corundum showing a steady decrease. The reason for this lies in the lack of uniformity and grinding efficiency of the natural minerals and the possibility of exact duplication of quality in the electric furnace product. It is also possible to give such products varying characteristics for various uses, the accomplishment of which depends on the skill of the manufacturer and knowledge of the laws governing its properties. Such materials are therefore in use varying from an alumina content of 70% to one of over 99%.

As an adjunct to and an offshoot of this industry, the aluminous refractory is coming into its own. I had the pleasure of bringing this material to public notice in this hall in a paper before the Electrochemical Society in April, 1911. While these articles are of little account as consumers of Alumina, they are of considerable interest and value to the laboratory worker. The demands are increasing steadily as the users become better acquainted with the properties. One of the problems we have to contend with is to persuade the chemist that we have not attempted to furnish a sovereign remedy for all laboratory ills. The products may be varied in their properties, and an advantage in one direction is usually

*Read at a joint meeting of the New York Sections of American Electrochemical Society, American Chemical Society, and Society of Chemical Industry, at Chemist's Club, New York, February 7th, 1913.



accomplished by the sacrifice of some other quality. Numerous published criticisms have appeared, most of which would have been quite uncalled for if the problems had been submitted first to the manufacturer so that a selection of the proper grade could have been made—neither in the abrasive or refractory field is alundum a panacea. When we are told

the job, it is not very often that we fail.

In closing, let me say that new processes for purifying Aluminous materials are still of great interest to us. A chance of securing cheaper raw materials looks good to us and, from the user's standpoint, we wish each experimenter success in his own work.

1913 Sales Conference

Norton Company Salesmen Gather from Far and Near to Exchange Ideas for the Benefit of Norton Service and Norton Customers

The salesmen and demonstrators of Norton Company and Norton Grinding Company were in conference with the executive staff of the offices and factories during the week of January 6th to 11th. Two business sessions daily were held in the conference hall of the new Administration and Research Laboratories building and various vital subjects pertaining to the business were introduced by carefully prepared papers and discussed.

The annual sales conference has become a big factor in the development of "Norton Service"—a valuable service offered manufacturers in connection with their grinding problems. It represents a great clearing house for matter pertaining to grinding—a place where salesmen and demonstrators can present their knotty problems and ask for suggestions

and the experiences of other salesmen on similar grinding operations. In a great many instances other salesmen or members of the research laboratories present have been up against like conditions and have the solution.

There is one great primary object of the sales conference—to obtain a better knowledge of grinding conditions. Knowledge obtained through the combined experiences of the office, outside men, factory and research laboratories constitutes a power behind the sales organization that drives the product to success. It is the thing that enables a Norton representative to render a service that means to his customer greater production and greater economy in grinding.

Without the annual sales conference "Norton Service" would not be so efficient.

The Laboratory Applications of Alundum

Comment in "The Tech" (Published by Students of the Massachusetts Institute of Technology) on Address by K. E. Herrick, Refractory Department, Norton Company

The first use of Alundum, of which Mr. Herrick spoke, is due to its high refractive power. It is far superior to ordinary porcelain for the manufacture of crucibles, as it can stand a great deal more heating. Moreover, owing to its low co-efficient of expansion, it will endure very rapid heating and cooling. Its good thermal conductivity, in which it far excels porcelain, makes possible

fusions which must otherwise be made in platinum. Although it is very inert, chemically, it cannot be employed as a complete substitute for platinum, but as a supplement to the latter it is unexcelled.

Its second important application is that of a thermal conductor. As an inactive lining for furnaces, but one that will at the same time readily conduct



heat, it has proved very useful. It has been successfully employed in the melting of platinum, and it is said that an electric furnace in which the coil is wrapped around a hollow core of Alundum can be raised to this very great heat in the space of fifty minutes.

But what seems to be by far the most important use for Alundum is its porous property.

Alundum filters have only been on the market since last September, and though, like all things new, were considerably criticized, many prominent chemists at the present time use them exclusively.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A cutter grinder with capacity for $4\frac{1}{2}$ " to 36" diameter and $\frac{1}{8}$ " to 4" face, arranged to be driven by belt or motor, is a recent product of Ingersoll Milling Machine Co., Rockford, Ill. *American Machinist*, Jan. 23rd, 1913—page 163. *Machinery*, Feb., 1913—page 479.

Vertical and horizontal rotary oscillating surface grinder, an improved model of same type of machine formerly made by same company. Diameter of table 45"; floor space 6x9; weight 10,000 lbs. Built by Springfield Mfg. Co., Bridgeport, Conn. Described in *American Machinist*, Jan. 23rd, 1913—page 164.

Three styles of eye protectors intended for use of chippers, grinders, welders, etc., made by American Spectacle Co., New York, are described and illustrated in *American Machinist*, Jan. 23rd, 1913—page 164.

L. S. Rasmsen Lap Co., 1710 25th St., Rock Island, Ill., are manufacturing a rotary disc lap grinder which can also be used for clipper grinding.

Springfield combination dry and wet grinder is a new product of Springfield Mfg. Co., Bridgeport, Conn. Pump, tank, drain pan and special hood on right end. The left end is equipped for dry grinding as in model they have previously made. Built in three sizes and quoted as 12", 18" and 24". Has protected motor. *American Machinist*, Jan. 16th, 1913—page 124. *Machinery*, Feb., 1913—page 483.

Four new types of ball bearing disc grinding and polishing machines built by Gardner Machine Co., Beloit, Wis., are described in these technical journals: *Iron Age*, Jan. 30th, 1913, page 302; *Machinery*, Feb., 1913, page 483; *American Machinist*, Feb. 13th, 1913, page 289.

"Inspecting Before Grinding" is an article in *American Machinist*, Jan. 23rd, 1913—page 159-160, discussing difficulties encountered in grinding and the gains made by inspection.

A recent development of a vertical planer type grinder made by Springfield Mfg. Co., Bridgeport, Conn., consists in attachments that make it possible to tilt the housings carrying the vertical grinding spindle so that the machine will grind concave. *American Machinist*, Feb. 13th, 1913—page 289.

Chas. H. Besly & Co., Chicago, Ill., have brought out a double spindle ring wheel grinder of heavy service type designed for simultaneously grinding two parallel sides of work. *American Machinist*, Feb. 6th, 1913—page 250. *Iron Age*, Feb. 6th, 1913—page 365.

A cylindrical grinding machine with stationary work table and traversing wheel base is a new product of the Queen City Machine Tool Co., Cincinnati, Ohio. This is a plain cylindrical grinding machine in two swings, 10" and 12", and in lengths of 36", 48", 60" and 72" for each swing. *Machinery*, Feb., 1913—page 483.

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

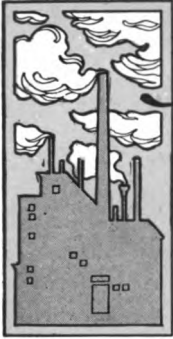
MARCH

1913



NORTON RESEARCH WORKERS

Their Intensive Study of the Problems Incident to the Manufacture and use of Grinding Wheels is a Factor in the Material Progress of the Norton Company and in the Swift Strides with which Grinding is Moving Forward to the Conquest of New Fields in the Industrial Arts.



Grits and Grinds

Vol. IV

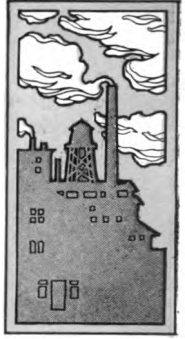
March, 1913

No. 11

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The Research Laboratories

**How Customers Are Helped in Selection of Right Grain and Grade, and Method
of Grinding—Service that Means Greater Economy and Larger Production
for Customers—Tests of All Raw Materials to Insure Uniformity and
Quality of Output—Development of New Products—Control of
Manufacturing Operations into which Enter Over
3,000 Variants**

By ROSS C. PURDY

Research Engineer, Norton Company

The Research Laboratories of the Norton Company are for a twofold purpose: the finding of the most efficient method of grinding or of polishing all sorts of materials; the perfection and regulation of the processes of manufacture of grinding wheels and other abrading and polishing products. The first function deals directly with propositions arising from without the Norton Company's factory, while the second has only an indirect yet very important bearing on these so-called "outside propositions."

In these days of uncounted numbers of special alloys and specially treated and tempered metals designed to meet the thousands of new requirements incident to the electrification of our transportation lines, the new heating and lighting devices, the automobile and auto-truck development, etc., there is a continuous demand for a new abrading tool. As soon as new ideas in either the mechanical or fine arts find expression in inventions, a demand is created for maximum efficiency in production. If a steel is developed for use in

long shafts of very small diameters having a torsional strength equal to those of larger diameters, we would have two distinct problems to be settled in the Research Laboratories. The first would be to find the combination of abrasives, hardness of the wheel and size of abrasives which would most efficiently grind this new steel. The second problem would be to find the method of grinding whereby this long shaft could be produced in perfect round throughout its entire length within at least 0.001 of an inch variation. A very large number of examples of this sort could be cited, each showing the absolute need of a research laboratory to investigate the problems of our customers, but we will confine ourselves to a few.

The relation between outside customers and the Mechanical Division of the Research Laboratories may be considered to be twofold: namely, testing of samples of work which customers are grinding, and going to customer's shop with a variety of grains and grades of wheels and supervising a test of these wheels under



customer's grinding conditions. A few samples of the first type of relation are as follows:

We remember two concerns, one across the street from the other, who were making malleable iron. In one factory, Alundum wheels were very satisfactory, while in the other factory they found Crystolon wheels to be the most satisfactory. Thinking that, possibly, customer's prejudice was the controlling factor in this instance, a Crystolon wheel was taken to the factory where Alundum was used successfully, and given a good fair trial against the Alundum wheel. It proved to be unsatisfactory. A similar test, but with a Crystolon wheel, was made in the other factory with the same result. The reason for this difference in wheel requirement in these neighboring malleable iron factories was that although the product of each was apparently very similar, the two irons differed very radically. The requirements of one could not have been taken as criteria for the other. To determine the wheel suitable for each required experimenting either at the customer's plant or in the laboratory.

We have in mind another situation where a customer had trouble with a special kind of high-speed steel. The concern in question manufactured inserted blade reamers, and the particular type which gave them trouble had fourteen of these inserted blades. Our customer had no difficulty whatever in grinding the steel which they had used previously to the trial of this special high-speed steel, but found that the wheels ordinarily used generated so much heat that the usefulness of the new high-speed steel was being destroyed. They accordingly obtained a softer grade of wheel, and this time ran into the difficulty of the wheel being so soft that by the time the thirteenth blade had been ground, it was found to be further out from the center of the reamer than the first blade which was ground. They sent us samples of this special high-speed steel and, as a result of our test, wheels were recommended which gave the customer satis-

faction. Had not the Research Laboratories assisted this customer, the chances are they would have been forced to return to the old brand of steel.

A firm desired to replace an old-fashioned type of saw used for cutting an extremely hard stone into slabs. On the face of things, this appeared to be an extremely difficult task and a successful outcome very doubtful. Before, however, jumping to conclusions, a series of tests were instituted, trying every kind of wheel with which this stone could possibly be cut economically, with the result that a dependable conclusion was finally reached that a grinding wheel for this purpose was not a practical consideration.

The customer had already practically decided to try the grinding wheel method on a very extensive scale, requiring the installation of a considerable amount of expensive machinery, before the matter was submitted to us for opinion, and the results of our tests served to save the misguided manufacturer many thousands of dollars.

The second feature of the work of the Mechanical Division of the Research Laboratories may be termed "Special Service." Occasionally, members of the Research Laboratories force have gone to a customer's plant, spent all the time necessary to become thoroughly familiar with the grinding conditions, supervised the conducting of a test, and have been able to show the customer where it was possible to make a saving in money.

Considering now that portion of the work in which the customer is interested only in an indirect way, we may say that one of the main functions of the Research Laboratories is the testing of raw materials to insure their uniformity and purity before any of them are used in the manufacturing processes. This not only enables the customer to obtain an article of a uniformly high character, but also enables the manufacturing department to turn out its product, whether it be wheels, abrasive material, or refractories, with no loss of time or labor in working with material of variable and undependable



compositions, which results in variable and often valueless products.

While the testing of the abrasive materials is quite naturally one of the most important operations, all bonding materials also, regardless of their nature, are subjected to rigid investigations and are required to comply with given adopted specifications before their use is permitted in the manufacturing operations. Practically all of the material, regardless of its nature, used in any measurable quantity in the Worcester works undergoes the same rigid inspection. Coal, oil, metals, clays, boiler compounds, belt dressings, etc., are all subject to the most critical examinations before being accepted.

The principal object is to increase the uniformity of raw material, general plant efficiency, and primarily the quality of the final commercial output.

To further insure uniformity and quality of output, the Research Laboratories also act as a bureau of standards. They outline methods of operation, which have been found by scientific investigation to be productive of the best results. Aside from a control of the raw materials used in the manufacture of grinding wheels, abrasives and refractories, individual operations, carried out during the process of manufacture, are also controlled. A time factor for various operations is set and periodically all weights, balances, and other measuring devices used throughout the plant are inspected and tested, so that accuracy and dependableness in the manufacturing operations may be positively assured.

The development of new products to meet the new demands occupies a very large portion of the Laboratory's attention. Bricks for polishing of floors and walls constructed of various cements, plasters and mortars; pencils and special shapes; tools for the finishing and polishing of small metal pieces; abrasive papers and

cloths; razor strops and hones; etc., are continually experimented with so as to keep abreast with the ever varying demand due to changes in material used in, and methods of manufacture of, the object which is to be polished or sharpened.

It would be quite natural to expect that these constantly changing requirements would call for a variety of tempers in the abrading materials. In some cases we need abrasive which will be extremely hard and brittle; in others, an abrasive which would be extremely hard and tough; while in others we would need the softer abrasives both brittle and tough. The demands in this respect would undoubtedly be greater if it were not for the fact that the cutting efficiency of the abrasive can be varied by the mixture of sizes of grain, by the quality and quantity of bond, and by the method of manufacture. The Laboratories are constantly seeking for the combinations of these several variants which would be most suitable for each grinding operation. The number of combinations of these variants in daily use in the factory is a little more than three thousand.

It ought to be evident from the citations made that the twofold purpose outlined in the first paragraph of this discussion calls for the following of several minute details: the keeping in mind of several variants, the perfect control of manufacturing processes, the anticipation of changes in materials and conditions so that the product may not only be manufactured correctly but that shipments may be made promptly. It is for these purposes, and to these ends, that the Norton Company has equipped laboratories in which accurate chemical and physical investigations may be made and in which the various manufacturing processes may be duplicated in detail although in miniature.

The Grinding of Manganese Steel

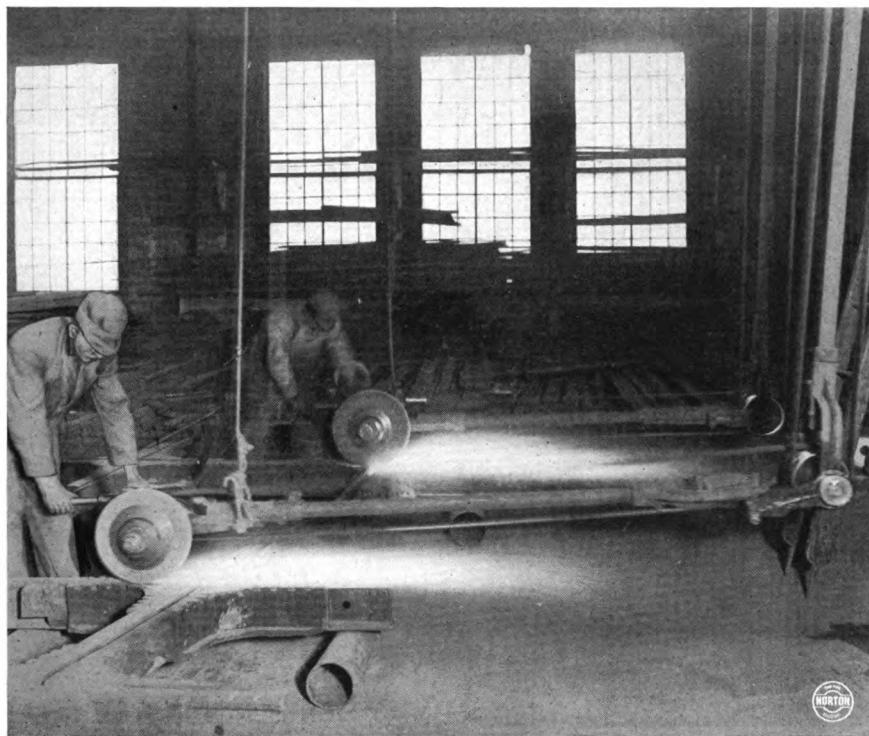
A Demonstrator's Experience Grinding Manganese Frogs, Crossings and Switches.
Planer Type and Swing Frame Machines used. Speed a Vital Factor.

By GEORGE S. WELKER

All ordinary commercial steel, either the Bessemer or Open Hearth, contains small quantities of manganese. In fact, manganese is quite necessary to the process of making steel. In the Bessemer process, it is added in the form of *spiegel-heisen* to impart the right carbon content. In Open Hearth, it is added to the molten metal in the ladle to deal with phosphorus and sulphur, but in both cases we want to find it cast off in the slag in other chemical forms after it has performed the desired work. When the amount remaining in the metal is less than one per cent., it attracts little atten-

tion, but on exceeding this amount it is very detrimental, and the amount which may be present before the metal becomes very brittle, rotten, in fact, almost absolutely worthless, is not over 2.5 per cent.

To R. A. Hadfield of England we are indebted for much of our present knowledge of manganese steel. In his experimental works he found that, by adding larger quantities of manganese and subjecting to certain heat treatments, he had discovered practically a new metal, very tenacious and strong, and very frequently, in fact almost always, referred to as very hard. Manganese steel is not



Surfacing Manganese Steel Cross-Overs with Alundum Wheel on Swing-Frame Grinding Machine.

hard. On the scleroscope an ordinary Bessemer steel rail scales 30 to 50, common chilled iron 65 to 75, while manganese shows only 40 to 50. With very much less hardness than fairly good unannealed carbon or high-speed steel, a moderate blow with the hammer will dent it. It is the great tenacity combined with the moderately high hardness that makes manganese steel the terror to machine tool and tool steel makers.

There is a growing appreciation of this metal. It is coming more and more into

I believe that fully 90 per cent. of the manganese steel castings now being made go into track work in the shape of frogs, crossings, switches, etc. It has to be shaped accurately to gauges and sizes, and the planer type of grinding machine and the swing frame are used almost exclusively.

I had considerable experience with this metal on the planer type of grinder in surfacing the faces of frogs, etc. An 18 x 2¼" wheel, 14 grade Q to R, running about 5000 surface feet, would work very nicely



Surfacing Tongue of Manganese Steel Switch with Alundum Wheel on Flexible Shaft.

use, and as there is so far but one commercial method of cutting it, that is with the grinding wheel, it is of particular interest to us.

We have said that it is extremely tough. If we hold a piece of manganese steel against the wheel with the same pressure that readily carries off particles of ordinary carbon steel, we will simply smear over and displace the particles of manganese, but we will not separate them from the parent body. We have to put on extra pressure to force the cutting points of the grain down into the metal, get under it, lift it up, tear out a string and cut it off.

until it had worn down to 16½ or 17 inches in diameter; then, unless we slowed the traverse of the work or increased the depth of the cut and put on more pressure, the wheel would load and soon generate heat. If we made the cut lighter it would smear over all the quicker and sometimes load up almost entirely smooth. We noticed that a porous wheel would continue to work good down to a much smaller diameter, and that we did not have to use nearly so much pressure on it as on a dense wheel.

We found even more trouble with the 14 x 1¼" wheels with an oval face used on a swing frame grinder for grinding out the

flange groove. Here, owing to the instability of the machine, we hardly dared increase wheel speed, yet we had a greater point of contact and could not put on so much pressure, the pressure being limited, of course, to the weight of the operator. This 14-inch wheel worked nicely until reduced to 13 inches, or perhaps a little less, then it would commence to load and run over the top of the metal instead of cutting it off. We tried using dressers on both of these operations, but our surface speed was too slow, and the wheel would cut only for a very few minutes after being dressed off entirely clean.

It was clearly demonstrated to us that so long as the wheel cut itself perfectly free, it worked good, but the moment the speed got below a certain point the metal commenced to flow—that is, to smear out under the wheel pressure and not cut off, and then we were done for and had to dress the wheel every few minutes or put on a wheel of larger diameter. We con-

cluded that speed was the one requisite with this manganese steel; to cut it off before it knew we were coming and had time to dodge. The planer type of machines were all repaired and put in good shape and the 18-inch wheels speeded up. They did nicely until down to 15 or 15½ inches, when they were changed to spindles which gave practically the same surface speed, and worn down to a stub we felt free to throw away.

Practically the same procedure was gone through with on the swing grinders. A good strong boiler plate hood was added, the wheel speeded up and the results were very gratifying.

From my experience in this particular plant, I am sort of settled in my notions as to what will win out in grinding this metal. Give us a very coarse No. 6 or No. 8 grain, made as open as possible consistent with strength to run up to 7,000 feet surface speed. I am sure you will find high speed to be the secret of success.

Paper Knife Grinding

**A Reader Claims That a Keen Edge Cannot be Obtained by Grinding
Against the Edge—That in Paper Knife Grinding the Knife
Should be Held Against the Wheel so that the
Motion will be from the Body of the
Knife Toward the Edge.**

The Geo. C. James Mfg. Co.
Machinery for
Printers and Bookbinders
Telephone Canal 755 538 Reading Road
Cincinnati, O.
Feb. 12, 1913.

NORTON COMPANY,
Worcester, Mass.

GENTLEMEN:

Your article in the December number of Grits and Grinds on grinding paper knives is very good, but don't you think you have made a mistake in recommending that the knife be clamped with the cutting edge toward the stone, so the motion of the wheel would be from the cutting edge toward the body of the knife? I have been selling knife grinding ma-

chines for thirty-eight years, and never yet saw one that was rigid enough to hold a knife as you propose, and another point, you cannot grind a really *keen* edge on anything by grinding against the edge. All you have to do is to use a magnifying glass and you will see the result of the two kinds of grinding. Grinding from the edge out sometimes leaves a little more feather, but with proper honing this can all be corrected without using a stick as you suggest. Using a stick to scrape the feather off nearly always dulls the edge in places.

If in honing the knife you use first a sharp grit stone and afterwards finish with a very hard smooth stone you can make the edge in a few minutes keen



enough to shave with. In regard to the bevel on the knife, I think the cup wheel is the best to grind with bevel, no matter how near it is worn out you can always make the bevel exactly what you want it.

To get the best result in cutting paper and miscellaneous stock, the grinding should be *very little* hollow. Simply enough so in holding it the stone would strike the body of the knife and the edge.

Any hollow more than this always has a tendency to make the edge thin and poor in the cutting qualities, just as you say.

This letter is sent merely as a suggestion and not a criticism of what you have said, and I trust you will receive it in the spirit in which I write it.

Yours truly,

GEO. C. JAMES.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Churchill Machine Tool Co., Ltd., Manchester, England, has brought out what is believed to be the largest precision surface grinding machine yet built. It is especially designed for accurately finishing cast iron plates up to 7' long by 6' wide after planing. Its net weight is 45,000 lbs. It is self-contained motor drive and all motions are automatic and the work is continuous. *American Machinist*, European edition, Feb. 27th, 1913—page 355.

A new swing grinding and polishing machine is being made by W. D. Pratt, Canton, Ohio. For safety the wheel is located at the side of the operator. *American Machinist*, Feb. 27th, 1913—page 375.

The Springfield Mfg. Co., Bridgeport, Conn., are building a shear-blade grinder with a number of interesting features. The machine will grind a knife 130" long, 8" wide and 3" thick. *American Machinist*, Feb. 27th, 1913—page 376.

Three types of swing frame grinding and polishing machines and a surface grinding and polishing machine are recent additions to the line built by the Excelsior Tool & Machine Co., East St. Louis, Ill. Two of the swing frame machines are designed for motor drive while the other is belt driven and is furnished with a counterweight to completely balance it.

The surface grinding and polishing machine is designed for grinding and surfacing flat castings by means of a rotating belt. The surface of the belt is set up in the same way as a polishing wheel with glue and abrasive. *Iron Age*, Feb. 27th, 1913—page 535.

An edge or ring wheel wet grinder has been brought out by The Springfield Mfg. Co., Bridgeport, Conn. The vertical movement is 8" and the cross-feed 6". The table is 13 x 34" and is made with T-slots and drain flanges. *American Machinist*, Feb. 20th, 1913—page 333.

Chas. H. Besly & Co., Chicago, Ill., have developed a motor driven lever-feed disc grinding machine, which contains a number of improvements. The motor is 15 H. P. and is designed to withstand the heavy over-loads to which the outfit may be subjected. *Iron Age*, Mar. 13th, 1913—page 653.

Some improvements have been incorporated recently in the type of internal grinder regularly produced by the Rivett Lathe & Grinder Co., Brighton, Mass. The principal new feature is the addition of a wet grinding attachment which makes the machine especially adapted for tool room use. *American Machinist*, Mar. 6th, 1913—page 415.

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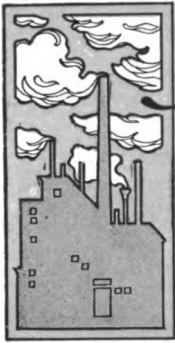
1913

APRIL

1913



Crystolon Wheels used on the International Floor Surfacing Machine to Surface the Steps of the New York Public Library



GRITS and GRINDS

Vol. V

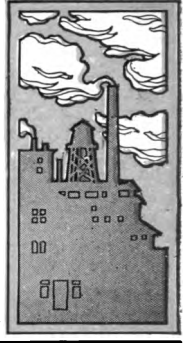
April, 1913

No. 1

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Some Uses of Crystolon Grinding Wheels

Excerpts From Paper Read Before Sales Conference

The following is abstracted from a paper read at the January, 1913, Norton Sales Conference and expresses in more or less condensed form the experiences and opinion in the use of Crystolon for various grinding operations, held by Mr. G. W. Thomson, Norton Company representative, resident in Philadelphia.

Crystolon in Cylindrical Grinding

The use of Crystolon in this class of grinding is comparatively new and it will be found necessary to conduct some rather exhaustive tests before a standard set of grade and grain combinations such as established for Alundum Wheels may be definitely determined upon. Local conditions govern each case to a great extent and where you will find one grain and grade which works successfully in one shop, the same wheel will not give satisfaction in some other shop on the same kind of work and apparently similar conditions. It not only depends on the make of the machine, the diameter of the piece to be ground, amount of stock to be taken off, finish required, but the personal element has also to be considered. In the application of Crystolon the selection of grade and grain is perhaps more exacting than in those operations where Alundum constitutes the abrasive. While such factors are still undetermined, we have had some splendid reports on Crystolon wheels in grinding cylinders, pistons, plungers and rolls on the Norton, Brown & Sharpe and

Landis Machines. The details of some of the writer's experiences in these operations may be helpful to others when called upon to prescribe a wheel for some certain work.

Internal Grinding of Cast Iron Automobile Cylinders

I believe you will find that most of the operators grinding cylinders prefer to use the same wheel for roughing and finishing. We have had some very good reports, finding that wheels 36 Grades J and K and 46 Grades J and K work entirely satisfactorily in most instances. There seems to be quite a variation in the character of the iron used, so this must be taken into consideration when wheels are selected for trial.

Chilled Rolls

The grains and grades that should be supplied for this class of work are largely dependent on the type of machine on which the rolls are ground, the diameter of the roll and whether it is a rough or finish grinding. To my mind, this is one of the most difficult operations which we have to contend with. One of the largest

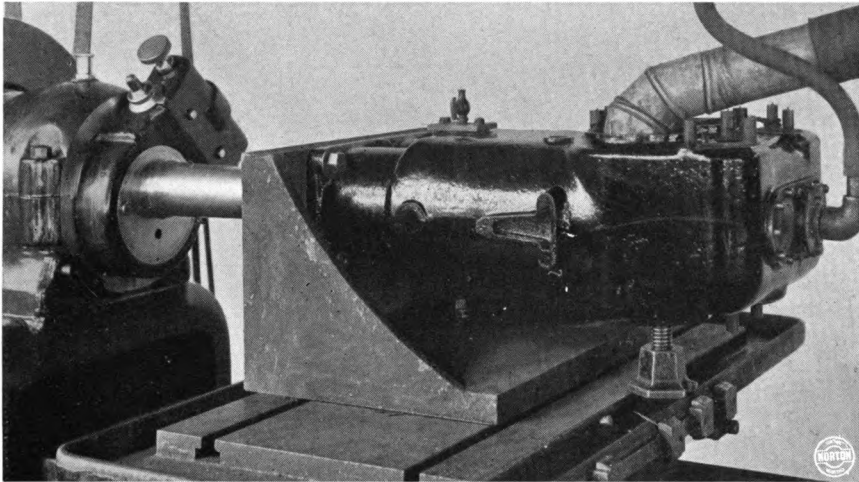


manufacturers of rolls, first rough grinds and then finish grinds, which, of course, requires different grains and grades for the two operations. Concerns who use rolls for commercial purposes and have installed machines for their re-grinding as a rule use the wheels for touching up, which, in most cases, requires a happy medium between a roughing and finishing wheel. We have supplied to such custom-

of others, but the combinations suggested above will serve as a guide.

Automatic Surfacing

There are now in the market a number of automatic vertical surface grinding machines for the grinding of the flat surface of various forms of cast iron, brass, bronze, aluminum and rubber packing, brick, etc. This is perhaps the most sensitive method of grinding as affecting proper



A Cast Iron Automobile Cylinder, With Steam Heat Used to Lessen Chance of Distortion, Being Ground Internally With a Crystolon Wheel

ers for use on the Farrel and Poole Grinders 50 Grade 2, 50 Grade 2½ and 80 Grade 1½ elastic wheels that have worked very satisfactorily. There are other concerns that do not have sufficient grinding to justify their installing a special machine and have remodeled a lathe for the purpose. Naturally the rigidity and massiveness of a special machine in such cases is lacking and we have supplied Vitrified Crystolon wheels ranging from 46 to 60 grain, N to P grades that accomplish the work satisfactorily.

This class of grinding is one in which it is almost impossible to specify standard grains and grades owing to the varying conditions and it is necessary to consider each individual case quite independent

grain and grade. On account of the large contact a comparatively coarse and soft cup or cylinder wheel is required. There are so many variables entering into this form of grinding that it is not possible to build strongly upon data found to govern other similar operations. Each case requires its own trials to determine the most effective grain and grade; however, they are more or less limited in grain from 16 to 36 and in grade from G to J.

General Snagging of Cast Iron Parts

This is one of the largest fields for the Crystolon wheel and we have found our 24 Grade R to be the best general wheel. There are occasions, of course, where it is necessary to furnish a wheel coarser or slightly finer and harder, dependent upon



the conditions. It has been my experience that wheels mounted on swing frame grinders should be harder in grade than those furnished for use on substantial floor stands, which is but natural.

Bath Tubs

Of the various types of bath tubs that require grinding are those made of cast iron which are either painted or enameled after grinding, also those made entirely of porcelain. For the grinding of cast iron bath tubs, we have supplied 6" wheels, used mainly on flexible shaft machines, 24 Grades S and T, 30 Grades R and S, and for heavier work, 18" wheels 24 Grades R and S, all of which have given excellent satisfaction. In the porcelain industry there are a number of operations such as smoothing, shaping holes and straightening the edges. The first two operations are accomplished by the use of small cone-shaped wheels, also 4" straight wheels mounted on a flexible shaft. We have found the Crystolon wheel No. 36 to No. 46, O to P to work very well. For the surfacing or edging work on porcelain in such forms as tubs, lavatory bowls and basins, most of the manufacturers use an open side planer-type machine carrying a cylinder $41\frac{1}{2} \times 6\frac{1}{4} \times 2\frac{1}{4}$ " made up of 12 segments, the piece being held to the table which passes automatically back and forth before the wheel. Porcelain being very easily affected by heat, it is absolutely necessary to employ a grain and grade combination that will not blister or crack the work. Evidently some of the concerns have denser material than others so that it has been necessary to experiment with each, to determine the proper grain and grade for their material. We have supplied 36-O in one instance which gives excellent service, while in others it has been necessary to furnish a softer grade viz: 36-M to obtain equally satisfactory results.

Brake Shoes and Friction Plates

To do this work successfully we have found it necessary to furnish very hard wheels. In a number of places we have supplied 24-U and 30-T and W that have

worked well. I believe if wheels of this character are furnished for this work, they will be found satisfactory in practically all cases.

It must be borne in mind, however, that the manufacturers of the above material do not all use the same foundry mixtures, hence, there is a variation in the iron, which, of course, influences the selection of a wheel between the limits indicated.

Hollow Ware

Various shapes and forms of wheels used such as spider or skillet wheels, pot balls, muzzling balls, maslin balls, also solid disc wheels are used for this class of grinding. Wheels and balls ranging from 24 to 46 Grain, P to U Grades give satisfaction depending on the type of machinery used in the manufacture, quality of material, class of labor, and whether edge or inside grinding is to be performed. Recently we had occasion to supply a very large assortment of wheels to a manufacturer who employs prison labor, for the grinding of hollow ware and cheap forms of cast iron, such as basins, flush tanks, sewer traps and hoppers. Since this class of labor is not as efficient as more experienced workmen, the customer has found it to his advantage to use Grade U almost entirely on all operations.

Cast and Chilled Plow Parts

For the grinding of the above parts, we are supplying 20 to 30 Grain, R and S Grades which are working very satisfactorily.

Radiators

Most of the floor and wall radiators now manufactured have a very sharp and narrow fin of considerable length, so in consequence it is necessary to furnish a wheel sufficiently hard to offset the dresser-like action of the fin. For this work, we have found that our Crystolon wheel 24 to 30 Grain, T or U Grades gives very satisfactory service.

Sad Irons

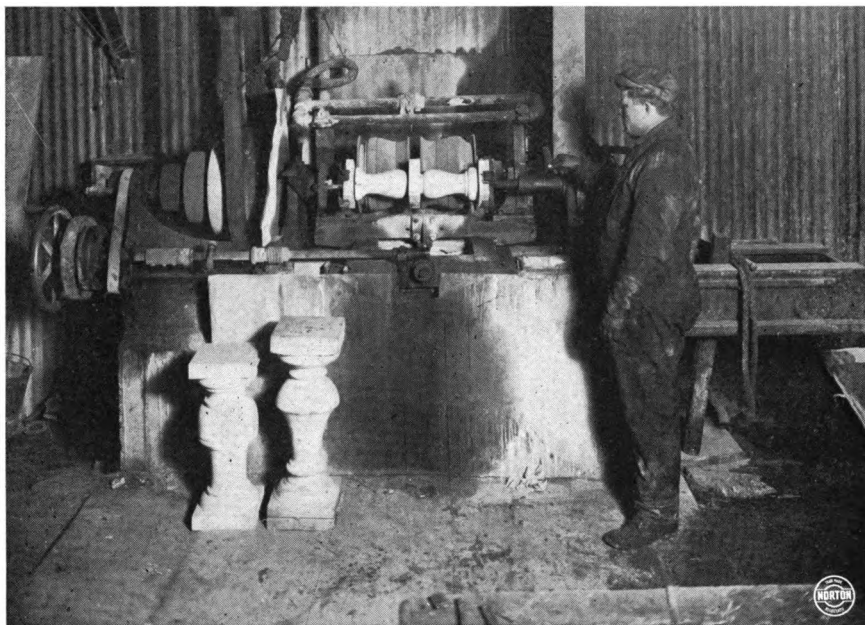
There is a marked increase in the manufacture of Sad Irons and in consequence a greater demand for the Carbide

of Silicon wheel. The method of grinding is varied, however, viz: off-hand, semi-automatic; also, there is more or less variation in the hardness of the iron used. For the off-hand grinding, we furnish 24 Grade R, 30 Grade R, and 36 Grade R, all of which have given very good satisfaction. In a number of cases our customers are using 60-Grade P, in a second operation,

giving general satisfaction. You will find that manufacturers of this material are using wheels 18 to 30" diameter, and the applicable grade and grain combinations do not vary between wide limits.

Stove Castings

We have been extremely successful in the testing of our wheels on this class of



Baluster Lathe Grinding Machine Equipped With Drums of Crystolon Wheels

which obviates the necessity of the usual first operation with canvas wheels set up with grain. For the semi-automatic grinding, we have supplied one manufacturer with a Crystolon cylinder 16 x 8, 4" rim, 24 Grade L, that worked particularly well. Another customer has designed an automatic vertical surfacing machine carrying a cylinder 12 x 5½", 1" rim. From preliminary investigations, the indications are that a 60 Grade I or J will do the work most satisfactorily.

Soil Pipe and Fittings

For this class of grinding we are supplying wheels 24 and 30-R, S and T, which are

work and for general snagging we find our 24 Grade R, 24 Grade S and 30 Grade R to work very satisfactorily. Where it has been necessary to have a wheel hold up on the corners, the 30 Grade R wheels in most cases work satisfactorily although in some instances it has been found necessary to go as fine as 36 and sometimes as hard as Grade S to meet the requirements. The Robinson Polishing Machine is sometimes used for the rough grinding of stove parts. For the work called notching, we have supplied Vitrified Crystolon wheels 46 Grade S and T, that work very successfully.



Aluminum, Brass and Bronze

This is another class of off-hand grinding on which we have been particularly successful. For the general snagging of all classes of brass and bronze, we have furnished wheels 24 to 36 Grain, P to R Grades that have given splendid satisfaction. The most popular grains and grades seem to be 24-Q, 30-P, and 30-Q. For Aluminum 36-4 Elastic and 20 to 40 Grade P Vitrified have proven satisfactory.

Machine Shop Use

We have always felt, and rightly so, that for the above purpose our Alundum wheel was better adapted than any other, due to the fact that in most cases the majority of the work to be ground is steel. However, I have found a number of shops where a preference for the Carbide of Silicon wheel is expressed. In meeting this particular demand usually found based on some logical reason, but sometimes simply prejudice, a 24 Grade Q wheel will render as satisfactory service as any Carbide of Silicon general purpose wheel can be expected to.

Carbon

For the cutting of Carbon we have supplied wheels from 6 to 12" diameter, $\frac{1}{8}$ " to $\frac{3}{4}$ " thick, of Crystolon in 36 Grade 5, Elastic that have given excellent service, in fact, in most cases far superior to anything the customer has ever used. Crystolon is adapted for the grinding of all kinds of carbon and the grain and grade is somewhat dependent on the method of grinding. More recently, Crystolon Vulcanite wheels have under certain conditions proven very successful.

Feathers

One of the most unusual operations that we have been called upon to furnish wheels for is the grinding of quills of feathers. One manufacturer is using a roll $4\frac{1}{2}$ x 10 x $1\frac{1}{4}$ " for the pointing or sharpening of the quills. A Crystolon roll 24 Grade P is successful on this work.

Horn and Bone

The pieces of Horn and Bone such as are used in pipe stems are ground semi-

automatically and for the roughing we furnish 30 Grade O which shapes the piece, after which it is worked on a 60 Grade O wheel to a fairly smooth finish. From this operation the pieces are polished by hand on covered wheels and afterwards given an oil bath.

Leather

Leather industries are now using solid manufactured grinding wheels or drums for finishing skins to be used in making gloves. These drums are 18" in length, by 16" largest diameter, tapering to 13" at the ends, and of 60 Grain, M Grade being found successful.

Soapstone

We have supplied to the manufacturers of soapstone in its various forms Crystolon wheels 12 x $\frac{1}{2}$ " - 46 Grade M, for cutting slots or grooves, that gave good satisfaction; also wheels 16 x 3" and 16 x 4", 14 Grade P that have given splendid service, all of which are used on a surface grinder of the planer type. In this manufacture there are used also considerable quantities of segments which go together to make up a wheel used on a vertical spindle for surfacing slabs. This operation is very similar to the grinding of marble. There has recently been developed a floor surfacing machine on which are used bricks 1 x 2 x 4" and which is vastly superior to the former method of doing the work by hand.

Crystolon in the Marble Trade

The advantages of marble for interior finish are being recognized more and more, and the introduction of carbide of silicon for working it has reduced its cost. This wheel has no detrimental effect on the marble and leaves the slab or block just as perfect as it was before it was quarried.

Some recent tests with a 10 x $\frac{1}{4}$ " Crystolon wheel made by the elastic process in coping pink Tennessee marble 1" thick, at the rate of 4' per minute, proved very successful. The wheels showed practically no reduction in diameter after 20 running feet had been coped and was not dull enough to need dressing.



Moulding wheels are from 8" to 18" in diameter and 1" to 20" in width. It is a common practice to use several wheels in a gang to make up the desired width. The grain depends upon the amount of stock to be removed. Nos. 4, 6, 10 and 16 are commonly used for roughing; No. 40 grain is as fine as necessary for finishing. The hardness of the wheel depends on the marble and size of grain used. Grades O to R in wheels of coarse grains, and grade M in wheels in Nos. 36 to 46 grains are in common use.

Pearl Grinding

Crystolon is particularly adapted for cutting such soft material as pearl shells. The principle industry is button manufacturing. After the buttons have been blanked out the shell, they are ready for operation called "Backing." The Crystolon wheel is used successfully on this operation. The wheels are about 12 x 3½", Nos. 36 to 46 Grains, M to O and sometimes Grades P to Q, depending on the type of machine used.

There are various other operations where Crystolon wheels are successful, but this is a subject that cannot be handled by making general statements and one that should be treated by itself.

Sundry Uses

The Crystolon wheel is adapted for classes of grinding other than those mentioned, viz:—

Grinding off the tops of tumblers, which work is performed by automatic machines, using special shaped wheels 3⅞ x 1½" and 4⅞ x 1½".

For the grinding of fire brick and pressed brick.

For grinding rubber in its various degrees of hardness.

For the off-hand shaping of various kinds of wood covers or pocket knives and other styles of knives.

For the automatic grinding of large wooden spools.

In the form of blocks of special shapes for scouring and dressing rolls such as are

used in tin plate mills, rolling mills, etc.

In the form of pump blocks used by pump manufacturers and similar trades for scouring the inside of cast iron pump cylinders.

While it would be possible to give some data on grain and grade that is being successfully used in these various operations, it would lead too far afield since the conditions controlling them are so varied as to require a selection between rather wide limits. Suffice it in this connection to merely list these rather unusual operations and to emphasize the importance of weighing the local conditions in each case before a proper wheel selection can be made.

Bricks

There is a large and fruitful field for the Crystolon brick in different shapes and sizes. One of the chief uses is for rubbing or snagging of machine parts. For this particular work we have supplied 16 to 24 Grain, R to T Grades that performs the work successfully. Where the customer desires to obtain a smoother finish, we have furnished bricks in 60 to 80 Grain, P and Q Grades.

The glass industries use a quantity of sticks and bricks for the cleaning of glass moulds.

In the cut glass trade for the truing and dressing of the face of our mitre wheels.

In the granite industry for removing scratches on the edges and corners of slabs and in the soapstone trade for smoothing purposes.

In the electrical field repair men are supplied with bricks 6½ x 3½ x 2", 150-M which are freely used in smoothing up commutators.

For smoothing purposes in the manufacture of porcelain ware, we have supplied 36 to 46 Grains, P Grade.

For the rubbing or surfacing of concrete, mosaic, terrazzo and composition floors, we supply bricks from 24 to 36 Grain and M to S in grade. For truing covered wheels 16 to 24 grain, Q to R Grades are found desirable.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

"Simple Chucks for the Grinder" is an article by Walter G. Groocock, London, Eng., appearing in *American Machinist*, European edition, March 15th, 1913—page 323.

A new dry grinding machine with a single wheel 24 x 5" and a bench wet grinding machine with a wheel 12 x 2" introduced by Harper, Sons, & Bean, Ltd., Dudley, Eng., are described and illustrated in *American Machinist*, European edition, April 12th, 1913—page 77 E.

An emery wheel dresser with a guard of improved type is now manufactured by the Challenge Machine Co., Philadelphia, Pa. *American Machinist*, April 24th, 1913.

A motor-driven bench grinder with a wheel on each side is being built by the Wilson-Wolf Engineering Co., Ltd., Bradford, Eng. *American Machinist*, European edition, March 15th, 1913—page 53 E.

A disc grinding machine of the double spindle type with one wheel at the right end and a pair in the center is a recent product of the Gardner Machine Co., Beloit, Wis. *Iron Age*, March 27th, 1913—page 763. *Am. Mach.* March 13th, 1913—page 541.

Five types of electrically operated portable grinding machines have been brought out by the Van Dorn & Dutton Co., Cleveland, O., and are described and illustrated in *Iron Age*, March 27th, 1913—page 767; *American Machinist*, April 13th, 1913—page 667.

The Smith Electric Tool Co., Cincinnati O., has brought out an electric center grinder which can be operated by current from any lamp socket. *American Machinist*, March 27th, 1913—page 543.

A lathe grinding attachment in use in the factory of the American Specialty Mfg.

Company, Atlanta, Ga., is described in *American Machinist*, April 17th, 1913—page 643.

The Ransom Manufacturing Company, Oshkosh, Wis., has brought out a line of bench type grinders with provision for the ready attachment for wheel guards. This machine is made in four sizes. *American Machinist*, April 17th, 1913—page 668; *Iron Age*, April 10th, 1913—page 887.

C. J. Willet, Master Mechanic, Illinois Steel Co., Milwaukee, Wis., has devised a grinding wheel guard in which provision has been made for the gradual wearing way of the wheel. Described and illustrated in *Iron Trade Review*, April 17th, 1913—page 924.

The question of the sales guarantee is discussed by Robert J. Spence in "The Grinding Machine Demonstrator and the Sales Guarantee." *American Machinist*, European edition, March 29th, 1913—page 389-391.

S. Holmes & Co., Bradford, Eng., are making a small surface grinding machine carrying a disc on a vertical spindle driven by a pulley at the base. *American Machinist*, European edition, March 29th, 1913—page 63 E.

A wet plane-surface grinding machine for rapidly grinding plane surfaces whether light or heavy work with a capacity of 8 x 24" is a recent product of the Wilmarth & Morman Co., Grand Rapids, Mich. *American Machinist*, European edition, April 12th, 1913—page 484.

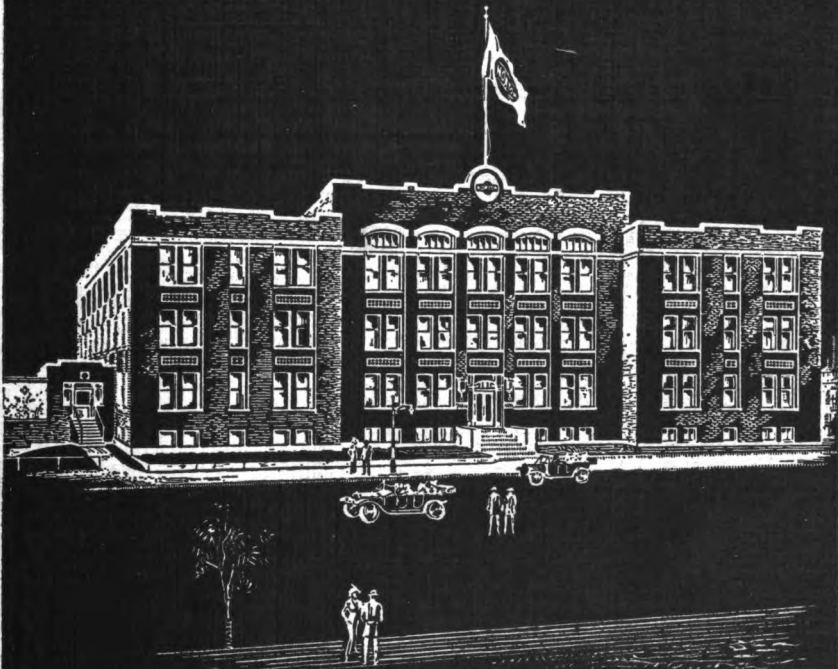
"Pneumatic Chucking on the Disc Grinder" shows a recent development in the manufacture of small, thin carbon blocks. *American Machinist*, April 17th, 1913—page 637.

GRITS and GRINDS

ADMINISTRATION NUMBER

MAY

1913



GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

MAY

1913



Norton Administration and Research Laboratory Building



Grits and Grinds

Vol. V

May, 1913

No. 1

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Norton Administrative Facilities

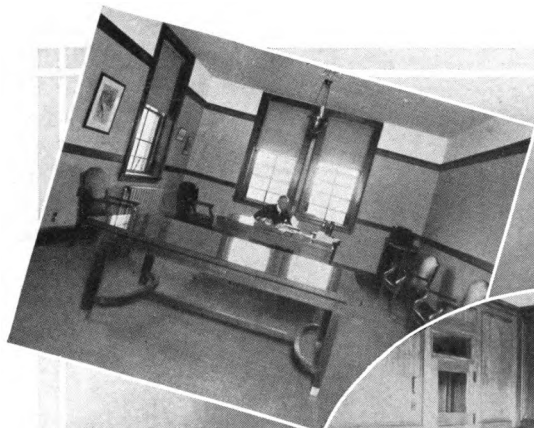
**How the Efforts and the Resources of the Executive Departments are Co-ordinated in the New Administration and Research Laboratory Building—
the Working Quarters of the Different Branches of the Organization
—a Glimpse of the Research Laboratory and its Equipment
to do Pioneer Work in the Grinding Field**

The erection of an Administration and Research Laboratory Building by Norton Company has brought about a considerable change in the physical appearance of the plant. This new building and the recent addition to the Kiln Plant changes the frontage of the Norton Company into line with the frontage of the Norton Grinding Company on New Bond Street, which has been greatly improved and made into a street of which the city may well be proud. The street has been newly surfaced into a substantial bituminous macadam road, concrete sidewalks laid upon the southern side, and street lights installed. The feed wires for these lights and for other electrical apparatus have been put in conduits.

The structure is roughly in the shape of a letter "U," extending 157 ft. 8 in. along New Bond Street, with the wings extending back 98 ft. 4 in. There was no intention to make the building ornate, but it has been so pleasingly designed that it makes a most attractive appearance. The exterior walls are of water struck brick, laid in Flemish bond, and the trimmings are of cast artificial stone. Prominent at the top of the building, over the main entrance, is the Norton trade

mark in the red, white and blue, in which it appears on the Company's business literature. This is surmounted by a staff from which flies a Norton flag, bearing in its center the same trade mark.

The interior wood work is of fumed oak with the exception of the reception hall which is finished in chestnut, and the President's office which is in gumwood. The walls and ceilings are of plaster. Throughout the building, the baseboards are of black slate, one of the many sanitary features which appear in every part of the edifice. These slate baseboards permit of most thorough scrubbing and cleaning of floors without marring any of the finished wood. The stairs are of iron with slate treads. The ceilings are in cream white, and the walls are finished in two tones of soft grey, making a particularly attractive contrast to the fumed oak woodwork. In offices and corridors the floors are covered with cork carpets; in the laboratories with linoleum. The basement has floors of concrete, and the lavatories and hospital have terrazzo floors and baseboards which meet without a joint, so that dirt and germs will find no opportunity for lodgment. In all the lavatories, the parti-



**General Manager
Secretary and Counsel**

**President
Superintendent and Works Manager**

OFFICES OF EXECUTIVES



tions are of white marble, and the fixtures of porcelain of the latest sanitary models, the same type as adopted by the Government for West Point Military Academy.

All parts of the building, except the corridors, are lighted by the indirect method. The reflectors, suspended by chains, are made of bronze and harmonize with the dark tone of the woodwork and the office furniture. The corridors are lighted by direct light, the groups of incandescent lamps being enclosed within domes.

Steam supplied from the central power plant is used to heat the building, both the direct and indirect methods being used, and the heat in each room is regulated by an installation of Johnson System thermostats. Every portion of the building is sprinklered, the sprinkler heads being so placed that they are in no way obtrusive. For additional fire protection, the corridors are plentifully supplied with Pyrene fire extinguishers. On every floor at each end of the main corridors are hygienic drinking fountains.

A system of electric clocks, regulated from a master clock, has been installed in the various departments. In convenient places in the offices are plugs furnishing power for the Edison business phonographs which are in use throughout the Administration building. An annunciator system puts each official in quick communication with the information desk and the staff of messengers. A private branch exchange telephone system is installed with a two panel switchboard permitting of 240 stations. At the present time, 134 stations are connected with the switchboard, and five trunk lines, keeping two operators busy. Eighteen additional phones in various offices have direct connection with the Worcester Exchange.

Effective ventilation is secured by means of three fan units installed in a room at the top of the building. From the largest of these, ducts lead to every office and corridor. One of the other

units takes care, through a special system of ducts, of ventilation of the laboratories, and the other unit, by yet another system, removes all odors and gases generated in the laboratories.

Installed in the basement is a rotary pump vacuum cleaning apparatus with pipes leading to numerous openings in each corridor. In the basement too are the suction and pressure tanks for the use of the laboratories. Here, also, are shower baths for the use of the tennis players who enjoy this popular pastime on the courts in the rear of the Administration Building. The art of the landscape gardener has made beautiful the enclosed area and the grounds surrounding this new building.

As one enters the building through the main doorway, he finds himself in a vestibule floored with tile, and enclosed mostly in glass. From this, one steps directly into a reception hall, in the center of which is the desk of the information clerk. The walls are finished in light chestnut, and on them are displayed the framed diplomas which have been awarded Norton Company for exhibitions in various important expositions.

A stairway at each end of the main corridor and a plunger elevator afford ready access to every floor. On each floor is a large steel and concrete vault. On each floor, too, are commodious locker rooms. On the top floor is a large well-equipped rest room for the women clerks and a large locker room for women on this floor is similarly equipped.

The central portion of the top floor is occupied wholly by a large Assembly hall used for Salesmen's Conferences, Summer Schools and other extension and instruction work in which the Norton Company is active. This particular hall will afford still further opportunity for the development of the policy of instruction and conference which makes the Norton staff one efficient unit, working as a whole for the promotion of Norton interests and those of its customers. In the front of the building on the second floor is a room given over to conferences



Cost Accountant
Billing Department
Credits and Collections

Cost Department
Auditor
Bookkeeping Department



Ceramic Laboratory

Balance Room

Library



of foremen or similar gatherings. The chairs in this room rise in tiers and face a platform and blackboard. It has long been the practice of the Norton Company to gather together frequently and regularly the foremen or other groups of workers who have a common subject to consider. This room is in frequent use and is a great factor in developing the interest in the prosperity and success of Norton Company which is characteristic of Norton workers.

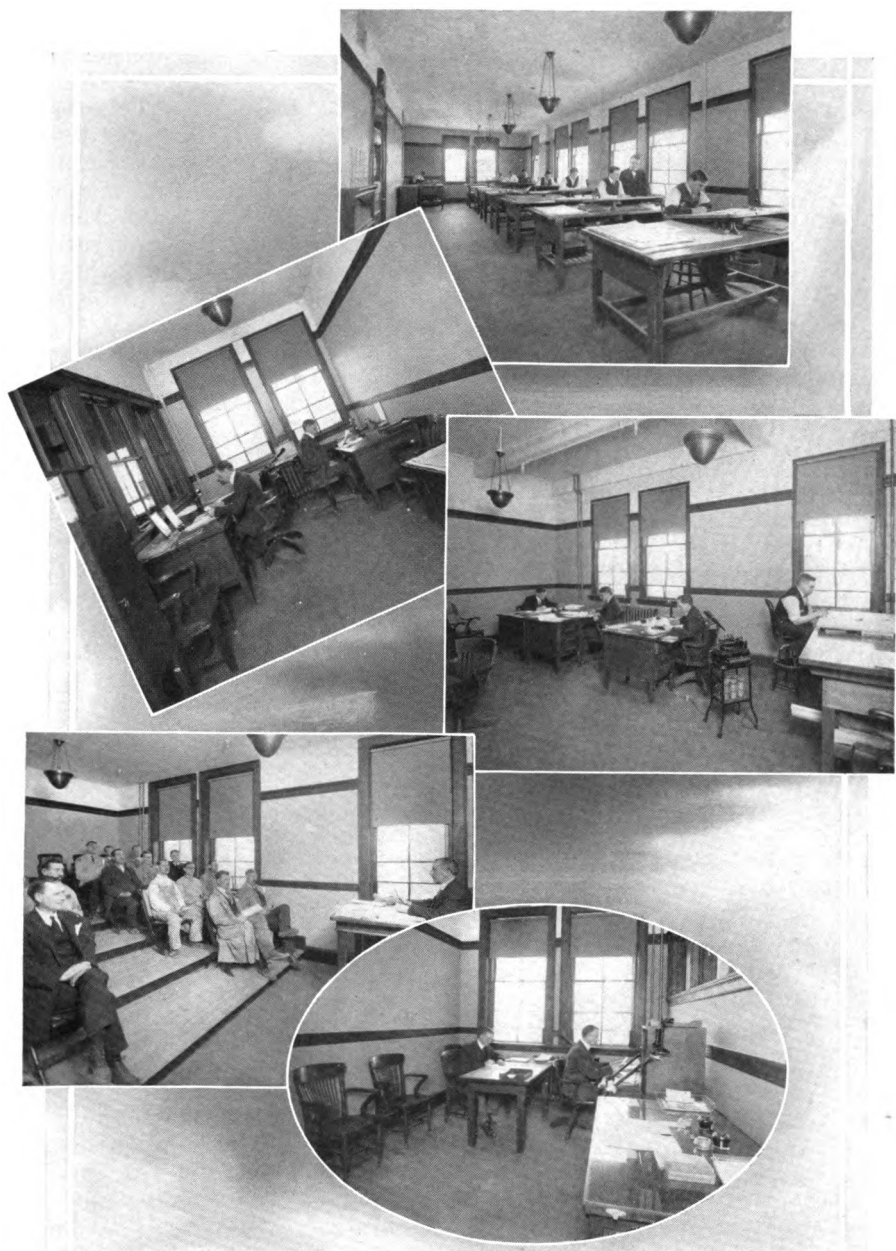
The office of President George I. Alden is on the second floor directly over the reception hall. This room also serves as a meeting room for the directors and is very quiet in tone with its gumwood walls and mahogany furniture. The office of Charles L. Allen, General Manager is a spacious room in the rear of the west wing of this same floor. The furniture in this office is of the type that has been selected as standard for the other offices in the building. The desks, of the sanitary type, are of fumed oak with brass feet. All desks and tables are glass covered. The dominant note of this and all other offices is simplicity and everything which is useful is in the place most convenient. The many things which frequently find a place in an office but which have no place in the working plan are noticeable by their absence. One rule of the Company which is particularly lived up to is that each and every desk shall be cleared every night, thus helping the work of the janitor and his staff and tending to raise the general standard of efficiency. Adjoining the office of the general manager is a smaller office for his secretary.

Across the hall is the office of Aldus C. Higgins, Secretary and Counsel of the Company. Opening from this is an office for Mr. Higgins' secretary.

The offices in the rear of this wing on the first floor are occupied by the sales manager and the assistant sales manager. Opening from the same corridor are four offices occupied by the assistants who take charge of the detailed work of the sales organization. One of these offices is

devoted to the work of the division which has charge of the sales of the refractory articles produced by the company. On this same floor occupying the remaining portion of the wing and a considerable portion of the main building is the order department. One large section of this is devoted to the order check files which are so placed as to be handy to every clerk in the department and to other employees who have occasion to consult the order check binders. On account of the many variants that enter into the manufacture of grinding wheels, the work of this department is most intricate, and accuracy and unfailing vigilance are necessary in every employee. The office of the head of the order department opens from the main corridor near the reception hall. The publicity department occupies a group of three rooms in the rear of the top floor in the east wing and a large room devoted to preparation of exhibits in the basement. An especially equipped mailing room and a photographer's room aid in the effectiveness of this branch of the sales organization. Every effort is made by the sales manager and his staff to keep in closest possible touch and to be active co-operators with the Norton stores in New York and Chicago and the numerous sales agencies throughout the established trade zones of civilization. One method by which close co-operation is brought about is by conducting a Summer School to which are invited member of the various agency organizations. Here they see at first hand the factors which enter into the manufacture of grinding wheels and are instructed by the various department heads in the details which will be helpful to them in their work as distributors of Norton products. Each year, also, the Norton salesmen are gathered together in an annual sales conference wherein experiences are described, new sales methods discussed and plans laid to set a still higher mark for the efficiency of Norton Grinding Wheels.

The office of the auditor and purchasing agent is located in the west wing on the second floor in close communi-



Chief Engineer

Conference Room

Drafting Room

Efficiency Department

Operating Engineer



cation with the various departments of which he is the head. Across the hall from the office of the auditor is that of the cashier who occupies a large room especially equipped for the work of his department. Adjoining this office is that of the head of the cost department opening directly into a large room in which are grouped the clerks of this department. This department has charge of cost keeping, time and payroll work and inventories. A special feature in this department is the grouping of desks so that four clerks are seated in such a manner that the work progresses from one to another without interruption. A new type of desk of the Company's design with disappearing carriage for comptometers is a feature that attracts the interest of many visitors. Next comes the office of the book-keeping department equipped with the time and labor saving devices that facilitate modern business accounting. Occupying the rear portion of the main building on this floor is the billing department with a considerable number of clerks at work in one large room and the billing machine operators in a smaller room adjoining. In the plan of organization the information clerk in the reception hall and the staff of messengers come under the jurisdiction of the auditor as does the stores department which is located in a portion of the main factory.

On the second floor of the east wing is located the office of the superintendent and the works manager with a smaller room adjoining occupied by the secretary of the works manager. Adjoining this is the office of the operating engineer and the general foreman. On the floor above are located the plants engineer and the chief draftsman, their office opening into a large light room which is given over to the use of the draftsmen. On the street floor in the front portion of the building is a room given over to the efficiency engineer and his staff.

Adjoining this in the front portion of the building is the hospital. This can be

reached by the employees of the manufacturing buildings without passing through any other portion of the office. The hospital has an ante-room, an examination room and an operating room. The company's physician is in attendance three hours a day and a skilled attendant capable of taking care of minor injuries is in attendance at all hours. This department known as the department of health and sanitation makes a careful and thorough physical examination of each employee and under its direction systematic medical and surgical care of employees and organized sanitation of the plant is carried on. The influence on the physical health and earning power of the workmen has been marked, and the influence of the system in making more cordial relations between workmen and owners has been made evident in many ways and increases as the work is better understood. The percentage of idle hours, the time that men are absent from their work, has been reduced from about three to one and one-half per cent. The sick or injured workmen who receive treatment at the company's hospital average 19.2 hours less of lost time than those employed who do not avail themselves of the opportunity urged upon them.

The research laboratories occupy a large portion of the basement, first and second floors in the east wing. The office of the research engineer is on the second floor in the rear. Adjoining this is the office of his assistant who is in charge of the mechanical division of the laboratory. Next along the corridor is the library wherein are the research books and issues of the technical and trade press. While first designed purely as a research laboratory library, its usefulness is being so extended that many departments avail themselves of its services. Adjoining is the record room of the analytical laboratory and the office of the chemist in charge of this division. Opening from this office and also from the corridor is the analytical laboratory and in the front



Office of Transcribing Department

Transcribing Department

Portion of Billing Department

Mailing Room

File Room

Office of Filing Department







use here, and one side of the room is equipped with a rack wherein is kept a stock of standard wheels for testing purposes.

The department of credits and collections has an office on the second floor in the west wing. The filing department is on the street floor, having a room for use of the clerks who may be looking up letters on file, and a large room filled with filing cabinets. In the basement below is another large room where are stored hundreds of transfer files. The order check file also has a large storage room in the basement. On the top floor in the west wing is the transcribing department and mailing room. Practically all of the correspondence of the different departments and most reports are dictated on Edison phonographs and the cylinders carried to this department where a group of busy typewriter operators have adequate and pleasant working quarters. The chief of this department and his assistant have an office adjoining. Beyond this is another small office devoted to the use of the telegraph clerk and the clerk who has charge of distributing the shop mail. Beyond this is another room devoted to duplicating apparatus and repair work on the phonograph equipment. Across the corridor is a room especially designed for the use of the mailing staff whose work is made easy by a number of special devices.

The offices vacated when this new building was put into use have been turned over to the traffic department and the catering department. On the first floor of the old office building, adjoining the shipping room are the offices of the traffic department. The world-wide distribution of Norton products and the rapid growth of the Norton Company make this department a busy place.

The floor above is given over to the dining room for officers and clerks. Here is installed a fine new kitchen which would be a credit to a modern, metro-

politan restaurant, and, as the illustration shows, the main hall of this cafeteria forms a very pleasant dining room. On one side are special rooms for men and women, and two rooms which may be devoted to private dining parties. In the front corner of this building, which is of triangular shape, is another small dining room which is in frequent use for conferences and consultations of department heads with visitors. On the floor above is a large room where several hundred workmen, most of whom bring their lunches, are supplied with such additional food, particularly hot drinks, soup, etc., as they may desire. Everything in the cafeteria and the workman's dining room is sold at cost, and is of the best quality. Both rooms are well patronized and play their parts in developing the good fellowship and sociability which characterize every assembly of Norton employees.

The plan of administrative organization was kept in mind when the design for this new building was made. The most frequent comment of visitors who have seen this office building is this: "How conveniently and logically you have arranged this building! Someone must have put a great deal of thought into its planning." If in this brief sketch of our new building we have created in your mind some idea of the extent of the resources of the Norton organization, and if we have conveyed to you some idea of the extent to which we are prepared to give our customers service, then we have accomplished what we set out to do. It is not because of size that we take pride in our new Administration and Research Laboratory building and its equipment in the way of furniture and working devices; rather, do we take pride in the efficiency of the organization which it houses as made manifest through the channels of trade and through the constant increase in the floor space devoted to the manufacture of Norton Grinding wheels, machinery, and other products.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A bench grinder designed with an aim to compactness and rigidity, which can be driven either from ceiling or floor, is being made by Frank MacVicar, Syracuse, N. Y. *American Machinist*, European edition, April 12th, 1913.

A method of grinding a rim of a large pulley is described by E. A. Thanton in "Grinding Large Pulleys." *American Machinist*, April 10th, 1913—page 596.

Mummert-Dixon Co., Hanover, Pa., are building an oilstone grinder which, adapted for tool room use in combination with the coarse and fine oilstone wheels, is mounted on a ring shaped abrasive wheel. Tool rests, slides and tables are adjustable at any angle. In motor driven type motor is placed on the base and belted to the pulley. *Iron Trade Review*, May 22nd, 1913—page 1180; *Iron Age*, May 8th, 1913—page 1124.

9" disc grinding machine with an adjustable single flat rest is being built by Bickford Machine Co., Greenfield, Mass. *American Machinist*, May 1st, 1913—page 751; *Iron Trade Review*, May 1st, 1913—page 1021; *Iron Age*, May 1st, 1913—page 1063.

A manufacturing universal grinding machine swinging 16" over the table and chucking 72" between centers is a new product of the Cincinnati Grinder Company, Cincinnati, O. Described and illustrated in *American Machinist*, May 22nd, 1913—page 878.

Bench grinder which can be driven either from the ceiling or from the floor, and especially designed with an aim to compactness and rigidity is a recent product of Frank MacVicar, Syracuse, N. Y. *American Machinist*, Mar. 20th, 1913—page 500.

A method of pneumatic chucking on a disc grinding machine has been developed in the experimental grinding department of Chas. H. Besly & Co., Chicago, Ill. Is described in *American Machinist*, European edition, May 10th, 1913—page 637.

Montgomery & Company, 105 Fulton St., New York City, have brought out a tool known as the Strong diamond holder for grinding wheel dressing diamond. *Iron Age*, May 15th—page 1219.

Formed cutter grinding machine designed to grind formed cutters radially with capacity for cutters up to 2 $\frac{3}{4}$ " diameter and $\frac{3}{8}$ " thick has been developed by Union Twist Drill Company, Athol, Mass. Another machine built by the same company is a universal cutter and reamer grinding machine designed for sharpening straight or spiral milling cutters, face mills, end mills and straight or taper reamers. A cup form of wheel is used. *American Machinist*, May 15th, 1913—page 838.

A double-wet tool grinding machine designed to eliminate the use of pumps and which may be operated either wet or dry is built by Sterling Grinding Wheel Company, Tiffin, O. *American Machinist*, May 8th—page 796.

A wet plane-surface grinder with the capacity of 8 x 24" is built by The Wilmarth & Mormon Co., Grand Rapids, Mich. Full details of this machine and several illustrations are found in *American Machinist*, Mar. 8th, 1913—page 484-85.

A motor-driven grinding machine, motor-driven dry grinding type, for use in foundry on heavy steel castings has been placed on the market by Ransom Mfg. Co., Oshkosh, Wis. *Iron Age*, May 22nd, 1913—page 1238.

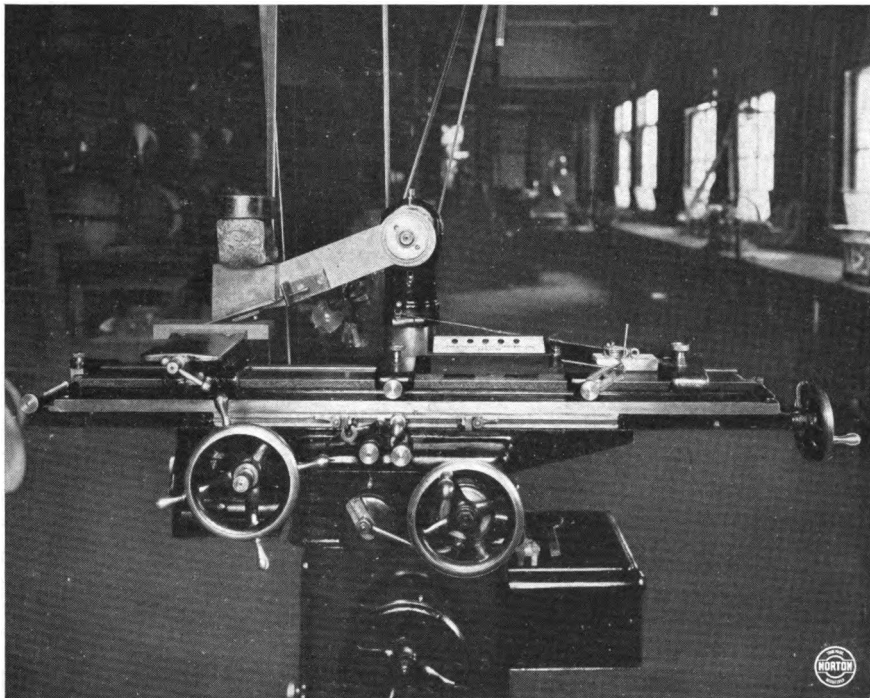
GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

JUNE

1913



Testing Device for Determining Cutting Ability and Resistance to Wear
of Oil Stones



Grits and Grinds

Vol. V

June, 1913

No. 2

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Method of Testing Oil Stones for Cutting and Wearing Qualities

How the Norton Research Laboratories Arrange Special Devices to Test Oil Stones—Some Results and Deductions

The two vital factors to consider when purchasing oil stones are cutting quality and wearing quality, the ideal being a stone which combines fast cutting quality with long life. In this age of efficient methods, when every effort is made to increase production and decrease cost, even oil stones must be selected with the greatest care to get maximum results.

That an accurate and reliable comparison might be made of the cutting and wearing qualities of oil stones, the mechanical division of the Norton Research Laboratories devised the equipment shown in the accompanying illustration.

A Norton Universal Tool and Cutter Grinding Machine is used. The special devices attached are for three purposes:—

To securely hold at a constant angle and under constant pressure a chisel or other tool to be sharpened; to clamp an oil stone to the table so that the stone traverses beneath the chisel at a fixed velocity; to find a method which will readily indicate the total distance travelled by the oil stone.

The tool chosen for this series of experiments was a Buck Bros. chisel with $1\frac{1}{2}$ " blade. This was pressed against

the stone by a weight of 20 lbs. which is equivalent to a mean pressure of approximately 40 lbs. per square inch. An adjustment of the screw at the back end of the chisel blade affords means for maintaining a constant bevel of the edge of the blade during the entire series of tests. An electric light behind the attachment is used for locating the position of the blade relative to the stone. The proper adjustment is shown when the line of light between the blade and stone is even. This is the most delicate test possible to secure even contact. The number of traverses of the table is indicated by a Schaffer & Budenberg revolution counter. As arranged, the dogs on the table were set for a traverse of 6", so each cycle of the table, as indicated on the counter, was equivalent to 1 ft. in linear measurement. The velocity at which the stone traversed under the chisel was 120" per minute.

The value of such a device may be best determined by a study of a recent test of oil stones made of two well known electric furnace abrasive materials. The results were somewhat surprising inasmuch as it had been very generally assumed that one of these two makes of oil stones possessed

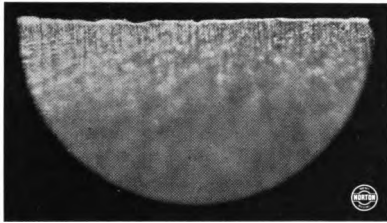


Fig. 1
With Coarse "A" Stone

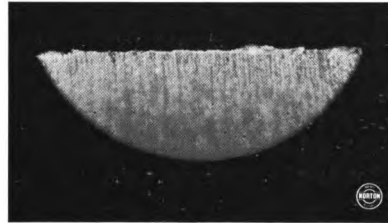


Fig. 2
With Coarse "B" Stone

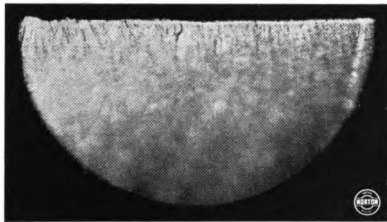


Fig. 3
With Medium "A" Stone

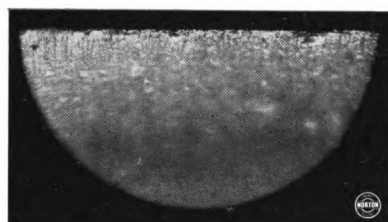


Fig. 4
With Medium "B" Stone

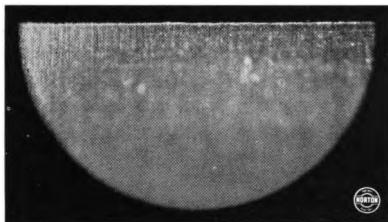


Fig. 5
With Fine "A" Stone

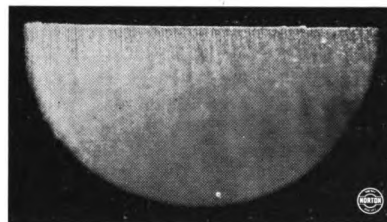


Fig. 6
With Fine "B" Stone

Appearance of the Chisel Edges After Sixty Strokes on Each of the Indicated Stones

faster cutting quality than the other but was shorter lived.

The method by which the tests were conducted and the comparative results shown later in this article determined, is fully described here so that it can be easily duplicated by any one interested.

It will prove profitable to those who use large quantities of oil stones to determine for themselves the saving made possible by determining the particular make of stone which will cut fastest, wear longest and keep its shape best.

Six stones bought in the open market

were used in this test; coarse, medium and fine of each make coinciding in shape and size. Two tests were made on each stone using a new side each time. During each test the traverse of the stone was 500 feet. All stones were flooded with oil during the tests and the chisel blade was weighed before and after each test. The conditions, therefore, were the same with the exception that one make of stone was oil filled, while the other was not, although a liberal amount of oil was used on both during the tests to prevent excessive loading or filling up of the pores.



The use of oil to prevent excessive loading or filling up of the pores made it impossible to obtain the wear upon the chisel and the wear of the stone at the same time. The method by which the wear of the stones was determined will be described later.

For descriptive purposes, the stone made of the tougher abrasive and harder bond—supposed to be the slow cutting—is called “A.” The stone of the more brittle abrasive and softer bond—supposed to be the fast cutting—is called “B.” As this article is intended to be a description of the laboratory method of test and not an advertisement or criticism of the stones tested, no other description will be used.

The following tabulation shows the total amount of wear on the blade after passing across 1,000 feet of stone. The penetration or degree of hardness of the stone was secured by using two grading tools on each stone, two penetrations being taken on each of the 2 x 8" sides of the stone and one on the 1 x 8" side. The grading tools were of the type regularly in use by Norton Company in determining the grade of grinding wheels.

Stone	Penetration Test of Grade	Chisel Wear	Stone Wear
A-coarse	22.	0.14524	1.80 oz.
B-coarse	58.	0.03318	5.08 oz.
A-medium	5.	0.16593	1.99 oz.
B-medium	86.5	0.15115	14.24 oz.
A-fine	5.1	0.11089	1.86 oz.
B-fine	25.	0.05973	6.28 oz.

(The above figures are the average of tests in each class as described)

The wear on the stone was determined in this manner. The stones were taken to a dry room where they remained for 24 hours in order to drive out all the water and superfluous oil and were then weighed. They were next tested on a rubbing bed used in the manufacture of oil stones. The stones were held on the rubbing bed under a constant weight of 16 lbs. which is equivalent to a pressure of 1 lb. per square inch. After the test, the stones were again placed in the dry room for 24 hours and then weighed.

In the tabulation of data the wear of the stone is expressed in ounces of stone wear per 15 minutes of test under 1 lb. of pressure per square inch.

It will be noted that in every case the B stones, as shown by the penetration, are much softer than the A. Being unfilled, the B stones required an excessive amount of oil as compared with the A stones and because of their softer grade grooves were worn in the B stones on the chisel test. It will be noted also that there is a marked difference in the coarse and fine stones in cutting quality, while this difference was not so noticeable in the medium stones. However, on the medium stones it is evident there was a great difference in the amount of stone wear.

The photomicrographs used for the accompanying illustrations show the chisel blade after having received 60 strokes. The magnification of the photographs is about 32 diameters.

The appearance of the chisel edge in these photomicrographs is not the best guide to the cutting ability of the tool. The slight lack of definition in the photographs of the chisel edges is due to refraction of the light—an effect incident to the necessary use of artificial light—which prevents a clear delineation of the saw-tooth appearance of the edge. The true guide is the appearance of the fine lines which show in the illustrations just below and perpendicular to the edge of the chisel. A close examination shows that while the number of cuts made by the corresponding grains in the coarse, medium and fine stones are practically the same for each kind of grit, the cuts made by the A stones are somewhat deeper. This tends to increase the cutting life of the chisel edge and to decrease the frequency with which the stone must be used.

Fig. 7 gives a very good idea of the manner in which the stones were affected by the tests upon the rubbing bed. Some of the B stones shown in this illustration were so much softer and wore away so much faster than the A stones that it was necessary to keep them on the rubbing bed only 7½ minutes, whereas the A stones



were tested 15 minutes. All the stones were of the same size when the test was started. A-2, A-10 and A-15, B-5 and B-6 were kept on the beds 15 minutes. B-1, B-2, B-3 and B-4, 7½ minutes.

These results are interesting in that they clearly demonstrate that the A stone, which has been generally referred to as a slower cutting stone, is in reality a faster cutting stone than the B stone.



How Stones Appeared After Test on Rubbing Bed to Determine Wear of Stones

Some definite conclusions arrived at by means of the tests are these:

The A coarse stone gives 2.8 times the wear of the B coarse stone.

The A medium stone gives a little over 7.1 times the wear of the B medium stone.

The A fine stone wore 3.3 times as long as the B fine stone.

The general conclusions are that the A stones have faster cutting quality, will wear longer and will keep their shape better than the B stones.

Further, that to remove the same amount of material in a given time greater pressure is necessary on the B stones than the A stones.

It is unquestionably true that mechanics using oil stones judge of the cutting quality of the stone by the sound made when passing the tool over the stone in the act of sharpening. It will interest users of oil stones to learn that what they consider fast cutting when rubbing the tool over a moderately soft stone is not in reality the fast cutting away of the material of the tool, but is the wearing away of the stone as made evident in these accurate tests. The inference is that the proper selection of oil stones will result in a big saving where oil stones are used extensively.

Chatter Marks

The Relation of Wheel Speed and Work Speed and its Effect in Surface Grinding—One Cause of Chatter Marks and How to Correct it

Chatter is the name applied to the phenomena which is sometimes present during a grinding operation, and when we remove the work from the machine, it is seen that the surface produced is not uniform, but uneven, and this unevenness is referred to as "Chatter Marks." Another name for chatter marks is "Flats." This name is not strictly correct, because if applied to cylindrical grinding work, it

conveys the idea that flat places have been produced on the work, which is really not the case. On cylindrical work, chatter marks are really curved surfaces.

There are various causes for chatter marks, the most prominent of which is vibration in the work. This in turn can be due to a number of causes, among which may be mentioned lack of rigidity in the machine on which the work is being

performed, or intermittent work speed, which may be the result of wearing of the gears in the headstock, if the machine is gear driven; or if the work is directly driven by a belt, chatter marks may be produced by the intermittent motion applied to the work through the belt.

The cause for chatter marks can some-

of chips produced and the average size of each chip; that is, if we should figure out the number of chips produced per minute and determine their average size, the number of chips multiplied by the average size of each would give us the production per minute.

Let us take the situation where the

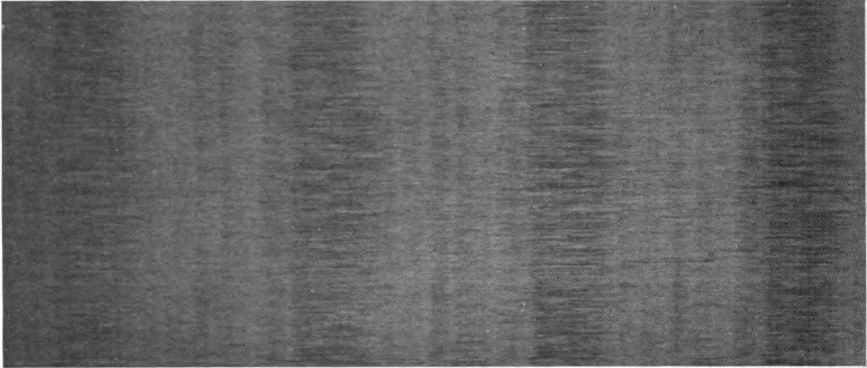


Figure 1
Surface when Relation of Wheel Speed to Work Speed is Incorrect

times be laid to the grinding wheel. If the wheel is running out of balance, chatter marks will be produced. If the wheel bearings are not properly adjusted and there is considerable play present, chatter marks will be produced on the work. However, in cylindrical grinding, chatter marks which can be traced directly to vibration or out of balance of the wheel are not of the same variety as those originating with the work. Chatter marks caused by the work not revolving as it should are uniform, that is, the spaces between them are of equal distance; while chatter marks which can be traced directly to the wheel are irregular.

The two figures shown are of surface grinding. No. 1 and No. 2 are of the same piece of steel, ground on the same machine, with the same table traverse; hence, production per minute was constant, but there were different wheel speeds. In Fig. No. 1, the speed was 1300 R. P. M., while in No. 2, it was 1000 R. P. M.

We can consider production per minute to be made up of two factors, the number

wheel speed was 1300 R. P. M. as a basis; then at 1000 R. P. M. we have a decrease in speed of about 23%. Now the number of chips produced per minute is determined by the number of cutting teeth on the wheel's face times the number of revolutions which the wheel makes per minute. Therefore, at 1000 R. P. M. we have 23% fewer chips cut off in a minute than at 1300 R. P. M. and since production remains constant, each chip must be 23% larger at 1000 R. P. M. than at 1300 R. P. M.

Cutting off large chips brings more pressure to bear on each individual cutting tooth than is brought to bear when a small chip is cut off, so that large chips will have a greater tendency to tear out cutting teeth from the wheel than would small chips. In other words, the wheel would wear enough to keep it cutting freely when producing large chips.

This is the condition which was present at 1000 R. P. M., namely, enough pressure was being brought to bear on each cutting tooth so that the wheel wore



enough to keep it free cutting, while at 1300 R. P. M. there was not enough pressure on each cutting tooth of the wheel to tear out that tooth when it became dull. The wheel was then in a glazed condition; it did not cut freely and caused all kinds of trouble, such as intermittent motion to the driving belt, with the result to the

particle by making it do a certain amount of work in a given time, so that it will be torn away from the wheel before it has had the chance to become dull, and produce the phenomena shown in Fig. 1. If the machine itself had been at fault, we could not have obtained satisfactory work at the higher table speed because, as the

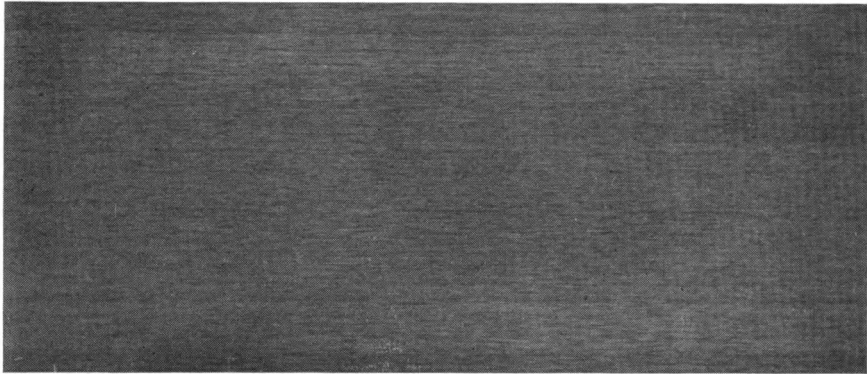


Figure 2
Surface when Relation of Wheel Speed to Work Speed is Correct

work shown in Fig. 1.

At the time that this phenomena was observed, the particular machine on which the operation was performed was not adjusted for a faster table speed than was used for Fig. 1. Later, however, the machine was readjusted so that a faster table speed could be obtained, and just as satisfactory work as is shown in Fig. 2 was obtained with 1,300 R. P. M. wheel speed and a faster table traverse. In other words, in order to eliminate chattering on surface grinding, it is necessary to bring a certain amount of pressure to bear on each individual cutting

amount of material cut off per minute, in other words the production, was increased, our power must have increased likewise, and if the machine were at fault from the point of view that it was not powerful enough for the operation, we would have had a case of worse chattering than that shown in Fig. 1. The direct cause of this kind of chattering is, undoubtedly, local heating, but the indirect and most important cause is the fact that we have an improper relation between the wheel speed and the amount of material removed per minute for this particular grain and grade of wheel.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A new grinding machine for snagging, provided with crane for handling heavy castings, is built by Mummert-Dixon Co., Hanover, Pa.; American Machinist, June

26th, 1913, page 1089; Iron Age, June 26th, 1913, page 1548.

A motor driven dry grinder provided with 3" spindle and with either direct or



alternating current motors is a recent product of the Ransom Mfg. Company, Oshkosh, Wis.; Foundry, June 1913, page 253; American Machinist, June 5th, 1913, page 961; Iron Trade Review, June 12th, 1913, page 1349.

A disc grinder with sliding table and ring wheel chuck is built by the Diamond Machine Company, Providence, R. I. The table is graduated for tilting and provided with micrometer stop for accurate duplication of work. American Machinist, May 29th, 1913, page 919.

An article on Internal Grinding, by Ulrich Steiner, appears in the American Machinist, June 5th, 1913, page 936.

An article describing methods of surface grinding on small pieces, by H. L. DeBaecke, appears in American Machinist, June 12th, 1913, page 970.

A grinding machine designed for grinding formed cutters radially has been placed upon the market by the Union Twist Drill Co., Athol, Mass.; Iron Age, June

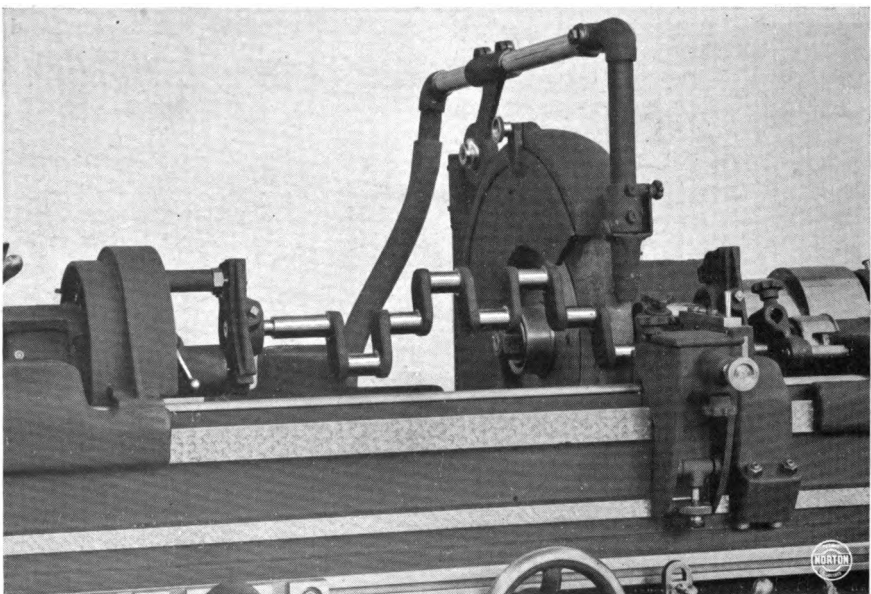
12th, 1913, page 1462; European edition, American Machinist, June 7th, 1913, page 838.

A new vertical surface grinding machine built by The Churchill Machine Tool Co., Ltd., Pendleton, Manchester, England, is described and illustrated in European edition, American Machinist, June 7th, 1913, page 127e.

A description of two machines designed for automatic grinding of woodworking tools, by Frederick Ellis, is found in American Machinist, June 19th, 1913, pages 1031-1033.

Two types of motor driven grinding machines adapted for medium heavy work built by Forbes & Myers, Worcester, Mass., are described and illustrated in American Machinist, June 19th, 1913, page 1045; Iron Age, June 19th, 1913, page 1485.

A special cam grinder is described and illustrated in an article by J. F. Brigham, in American Machinist, June 26th, 1913, page 1066.



Norton Method of Grinding Crankshafts

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

JULY

1913



Students and Instructors of Norton Company's
Summer School—1913



Grits and Grinds

Vol. V

July, 1913

No. 3

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Grinding Practice in European Automobile Plants

By GEORGES BOUILLON

Norton Company's European Demonstrator Relates his Observations of Grinding Methods, States Some of the Conditions that Affect Grinding Practice and, from his Experience, Furnishes a Record of Wheels in Common Use

This report is the result of the grinding practice I have noted in the automobile plants in my territory where a majority of the wheels used come from Norton Company.

It seems necessary to first point out that the wages of the workmen in Europe are not as high as in the United States and the price of the wheel is considerably higher; the disparity between the wage and the cost of the wheel is several times greater in France than in the United States. Because of this, the customer frequently finds it more economical to use a hard wheel in place of a softer wheel which will do the work more quickly because the wheel wear costs more than the time of the workman; for the same reason, many pieces that can be economically ground in the United States are made in Europe more cheaply on the lathe or milling machine. Some of the examples I will cite in this paper will serve to emphasize the foregoing remarks. In the automobile plants, the wages of a good grinder vary between O. fr. 80 (16 cents) and 1 fr. 10 (22 cents) per hour.

CYLINDRICAL GRINDING

Plain Grinding Many types of shafts, pins, etc. made of hardened steel are ground on Norton, Brown & Sharpe, Landis and Reinecker grinding machines. In making such pieces there are two operations: first, roughing, before the hardening, which is done on a lathe or a grinding machine; second, finishing the pieces after they have been hardened and tempered. 4.7 millimeters of stock are left to be removed in the grinding operation. It is necessary to leave a considerable amount of stock because many pieces are distorted in the tempering and hardening processes.

On the Landis and Brown & Sharpe machines the wheels most commonly used are 46 N and 50 M; sometimes we use 46 M for wheels having a thickness of 1" or more and occasionally 60 M on wheels ½" wide: on a Norton Plain Grinding Machine we use 24 combination, grades L and M.

**Crankshaft Grinding**

The machines used for crankshaft grinding are the Norton, the Landis and some plants use the Norton machines made by Ludw. Loewe & Co., Ltd., Berlin, Germany. The wheels most used on the Norton machines are 24 combination, grade N for roughing and 24 combination, grade M for finishing. Some concerns grind the crankshaft from the rough after it has been forged and in other places they turn them on the lathe before grinding; after either of these operations they leave 1 millimeter on the diameter to be removed in finishing operation. For roughing the crankshafts when they come from the forge, we have used with success wheels of 650 x 51 x 440 m/m. 36 P which with special mounting are used on the Landis. With such wheels we can rough out 200 40-point carbon nickel steel crankshafts; there are from 4 to 7 m/m to remove per bearing. The regular Landis shape of wheel, 24 x 2 x 12", 46 N roughed only 60 of them. Thus, the wheel cost for roughing for each crankshaft is O. fr. 70 (14 cents) with the first wheel and 1 fr. .85 (37 cents) with the second wheel.

For finishing—taking off the last m/m—the 46 N is used everywhere and works better than any other wheel; the regular shape is used. Many times we have had trouble caused by the breakage of the wheels of 78, 79 and 80 shape, always for the same reason—because the cast iron sleeves of the mounting were cracked or out of truth.

Camshaft Grinding

Camshafts are ground many different ways. They are forged or turned from the solid nickel steel bar. Some of them made of nickel steel are machined on a milling machine and not ground. The machines used for grinding come from Norton, Landis, Reinecker, German manufacturers and some machines are made by the customers themselves. On the Norton, 24 combination, grades L or N, and on the Landis, 46 grades L or N work satisfactorily. All the machines made in Europe, using wheels of small

diameters, give such poor work and such trouble to the customer that I do not think it is necessary to mention them in this report.

Piston Grinding

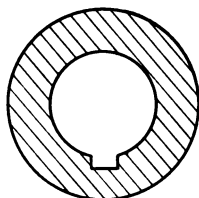
We have to use great care in suggesting wheels for piston grinding because the proportion of carbon in the cast iron changes very often. When there are but few points of carbon the Alundum wheel works very well, but when the cast iron is rich in carbon Crystolon wheels 36 L and 46 J give good results. Alundum 46 M is used to grind steel pistons.

Grinding Piston Rings

We mount several (about ten) cast iron piston rings on a special jig and grind them all together. 46 H Crystolon on American piston ring grinding machines used in European shops gives a very good finish. There is only one place where I have noticed oil stones used for polishing the rings after they have been ground; this method we cannot recommend because the work is not accurate and the piece will be out of truth.

INTERNAL GRINDING**General Work**

Most of the pieces ground are made of tempered hardened steel. This work has given us some trouble because it was done under bad conditions. The small wheels used have never been considered by the managers as an important matter and they have used on the machines all kinds of cheap wheels; all of them very hard. The workmen never use the diamond fixed on the machine for truing the wheel, so with a wheel too hard, with the speed of the work too fast, it is not possible to remove material inside the piece and the workman is obliged to use too much pressure with the wheel. This has resulted in work with a bad finish and the machine has been spoiled on account of the play of the shaft in its bearings. An instance is shown in the steel pinion with inside keyway shown in the sketch, herewith.



You can imagine what happens when the workman uses too much pressure:—when the wheel passes over the key-way both wheel and work are spoiled

immediately.

Our 38 Alundum has made a real improvement in the practice of internal grinding.

In many concerns they have repaired their machines and made special devices to hold the diamond on the machine where the devices for the machine had been lost. On machines having spindles revolving at comparatively slow speed, the wheels most commonly used are:

Wheel having thickness from 0 to $\frac{1}{4}$ ", 3860 M.

Wheel having thickness from $\frac{1}{4}$ " to $\frac{3}{8}$ ", 3850 M.

Wheel having over $\frac{3}{8}$ " thickness, 3846 M.

On American-made machines like Rivett or Heald, having practically the right surface speed, we use grades K or J. There are only two firms where they prefer the regular Alundum to No. 38; but this is only an idea of the workmen without any special reason.

Cylinder Grinding

The principal machines used for this work come from F. Schmaltz, and Mayer & Schmidt, (Germany), Brown and Sharpe and Heald. The principle of these machines is nearly the same and they are used to grind work varying in diameter from 3" to 5". There are very few plants where as yet they are doing cylinder grinding satisfactorily. The reasons are: variations in composition of cast iron, slow speed of wheel and incorrect proportion between the diameter of the wheel and the diameter of the work. In many cases the differences between the diameter of the wheel and the diameter of the work is not large enough and on account of the broad contact the wheel glazes rapidly.

Then, if we give them a wheel soft enough to work satisfactorily in the beginning, it will be too soft when it gets worn down and usually the spindle will not be speeded up to compensate for the wheel wear.

With wheel of a diameter at least $\frac{3}{8}$ " less than the diameter of the piece, Crystolon wheels 46K, 36L, and 30L are doing good work. In one shop, the cylinders are polished with emery and oil instead of being ground. In this way they get a very nice polish, but the work is not made with great accuracy.

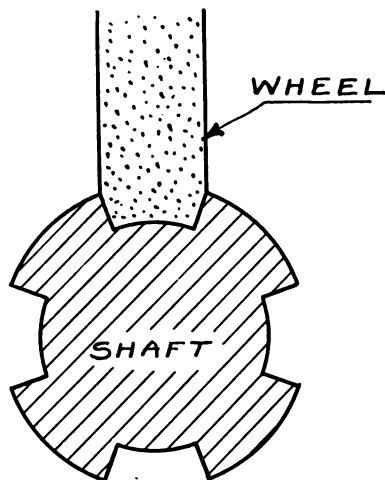
SURFACE GRINDING

While some American-made surface grinding machines are in use in automobile plants, there is much work that can be made more economically on the milling machine than on the grinding machine. For example: At the Automobile Renault in France, we have tried to grind aluminum carters. The wheel is an elastic cup wheel 12 x 4 x $8\frac{3}{8}$ " and very soft. The carter can be made on the milling machine in 20 minutes and the workman is paid 0 fr. .35 (7 cents). On the surface grinding machine it can be made in 4 minutes and the workman is paid 0 fr. .10 (2 cents). The wheel is sold for 53 fr. .60 and we can use only $3\frac{1}{4}$ " (about 80 m/m) of the height of the wheel; thus, each m/m of the wheel costs— $\frac{53 \text{ fr. } .60}{80}$

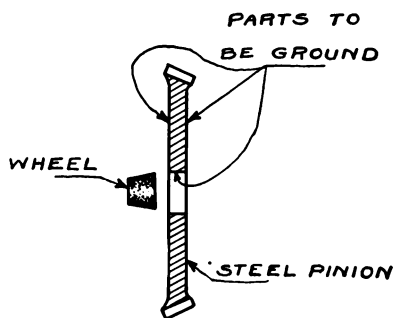
= 0 fr. .67. The wear of the wheel per piece is from 1 to $1\frac{1}{2}$ m/m, and the cost of the wheel per carter is from 0 fr. .67 (13.4 cents) to 1 franc (20 cents). As we can make 10 carters an hour, the wheel cost per hour is from 6 fr. .70 (\$1.34) to 10 francs (\$2.00). The cost of the piece on the grinding machine is: Wheel cost 1 fr., workman 0 fr. 10 = 1 fr. .10 (22 cents), but the cost of the piece on the milling machine equals 0 fr. .35 (7 cents). Of course, they can make three times as many pieces on the grinding machine as on the milling machine, but the pieces are so expensive that it is more economical to use the milling machine.



In some of the automobile plants, they are using surface grinding machines from Heald, Churchill and Germany. Some work wet and others dry, and they are used for surfacing cast iron piston rings and all kinds of tempered hardened steel rings. These machines have magnetic chuck and the wheel is of regular shape. Our silicate wheels 30 and 36, K or J, work very well indeed.



The Brown & Sharpe surface grinding machine is also used for grinding grooves in pinion shaft of the gear box. Here we use a hard wheel as it must keep the shape of the groove throughout the entire length of the cut. We have obtained satisfaction on this job with 3860 P, Alundum.



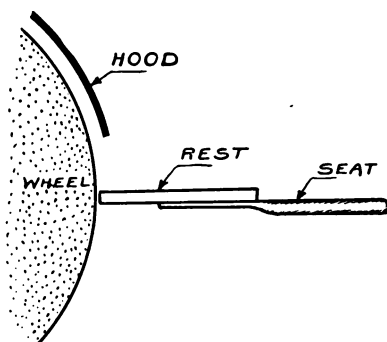
There are in many automobile plants large nickel steel or hardened steel pinions which must be ground internally and on the sides. For these two operations, we use the same wheel which must be fine and hard and we supply 3860 N to P for this work. The machines used for such work are made in Germany and the wheel can move in any direction.

It is not necessary in this report to speak of the tool room where the machines and wheels used are not especially adapted for automobile plants.

Snagging

Only the large concerns have very big snagging departments and they use wheels of about 24" diameter, in 30P and 20 Q for grinding all kinds of small castings.

I must mention one exception where this snagging is done under the best conditions I have ever seen. This is at De-launey, Belleville: St. Denis, France, on a heavy, well-built machine they use wheels of size 40 x 8 x 14", 16 P. Attached to the front of the machine there is a large rest and a seat for the workman (see sketch herewith). The wheel is



kept true and the rest is placed about 2 m/m from the wheel. Under such conditions, the workman can work with remarkable accuracy and in this plant they grind many pieces very economically.



Norton Summer School

For three successive years the Norton Company has conducted a summer school for the benefit of its agents' salesmen. That the summer school has been a success is made evident by the interest shown by the agents in sending their men to attend its sessions; that the school is valuable is shown, moreover, by the great interest manifested by those attending.

The group that formed the 1913 summer school was noticeably serious and earnest in their endeavor to learn all that the time would permit. The difficulty of absorbing from books certain kinds of information concerning grinding, had made them zealous in securing all the knowledge that could be gained by first-hand observation of grinding practice. But it would be manifestly unfair to say that the pupils who attended the summer school alone benefited from the five days of hard work. The intelligent questions and comment in the discussions following the lectures, were a source of inspiration to the Norton officials who took part in the conduct of the various sessions. For instance, certain questions were raised by the visitors that will keep Norton Research Laboratories busy for sometime and many interesting problems were discussed that will furnish material for study by the men in the field and the men in the factory.

The pupils also had opportunity to add to their knowledge of the grinding field and its possibilities during exchanges of experience which furnished one of the chief topics of conversation whenever a group of the students were together outside the lecture room. In one instance, an English delegate was asking if we had had any experience in furnishing grinding wheels for smoothing the bottoms of heavy nailed shoes. His inquiry was immediately answered by another delegate who told of his personal experience in working out just this problem in the country factories of Missouri where this class

of heavy shoe is made. The Missouri salesman detailed the steps taken to find the grain and grade that was satisfactory for this work and gave the Englishman full details both as to the grain, grade and size of wheel and the American process for doing this work. This instance was typical of the kind of help that both the visitors and Norton sales force obtained from these contributions of personal experiences by students from diverse and widely separated sections.

The object of the summer school is to give salesmen, part of whose time at least, is devoted to selling Norton Grinding Wheels, an insight into the materials, the processes, and the factory practice of the Norton Company and to make them familiar with the underlying principles of grinding methods that have come within the wide experience of the Norton staff of salesmen.

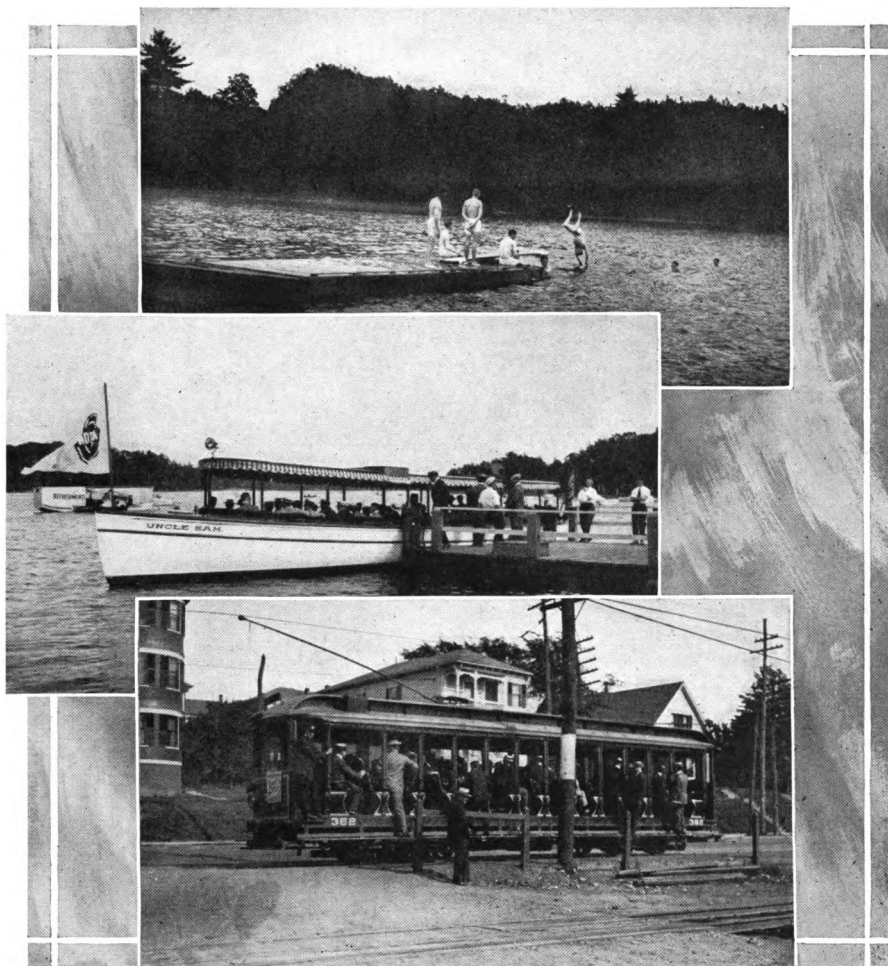
Most of the lectures were illustrated with lantern slides or with practical demonstrations. This plan of conducting summer schools is conducive to the benefit, not alone of the immediate group of salesmen, but even more of their customers.

The men who attended the summer school this year and those who attended in the two previous years are in a position to advance new ideas to their customers and to help them solve the grinding problems peculiar to their working conditions. It also gives those attending an insight into the facilities which the Norton Company offers toward the solution of complex grinding problems and shows them how to get adequate assistance from the factory. When one considers that the greatest problem confronting the makers of grinding wheels and grinding machinery to-day is the problem of teaching the intelligent use of grinding wheels, one gets a clear conception of the far-reaching effects of summer schools, salesmen's conferences and the other educational influences that characterize the Norton



policy. Probably no part of the whole week was more interesting to the visiting students than the time devoted to factory demonstrations. The fascination of actually helping to make a grinding wheel or

The time spent in the plant of the Norton Grinding Company was voted to be time well spent, as it affords opportunity to see so many and such varied grinding operations. The fact that some



Summer School Outing at Tatassit Canoe Club

of operating grinding machines was so great that the time scheduled for this work was far exceeded by the men in the demonstration groups. It is this kind of interest that make summer schools both pleasurable and profitable.

of these men were selling to the largest and best equipped manufacturing corporations in the world, served only to deepen their interest in a plant where "The Norton limit is the grinding limit." As one student put it, "when I next talk



Norton wheels after seeing your engineering departments and the efficiency shown in your manufacturing operations in both plants, I shall speak with the confidence that a man has who has seen for himself that Norton quality is not merely a sounding phrase, but is an accomplished fact."

One of the things that made this summer school pleasant for all concerned was the fact that the greater part of its sessions were held in the New Demonstration and Research Laboratory Building where the commodious assembly hall offered unusual facilities for the use of lantern slides and demonstrations; where the salesmen's room offered comfortable headquarters between sessions; where the various departments and laboratories were easily accessible.

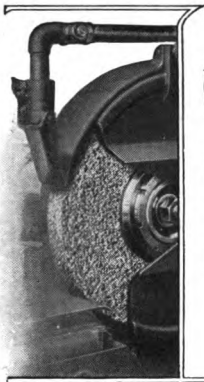
Some of the lectures delivered were these: "Illustrated Talk on Abrasives and the Manufacture of Grinding Wheels" "Grain and Grade—What Determines their Selection?" "Safety as Applied to Grinding Wheels;" "The Research Laboratory—Its Work;" "Bushing, Facing, Truing, Mounting and Balancing;" "Metals that are Ground;" "Grinding of Castings—Steel, Malleable Iron, Brass, Bronze, Aluminum and other Alloys;" "The value of Research Laboratories to Norton Company's Agents and Customers." "Efficiency and Grinding;" "Types of Machines Manufactured by Norton Grinding Company;" "Grinding Wheel Sparks;" "Publicity;" "Materials Other than Metals that are Ground;" "The Conditions which Determine the Selection of Alundum or Crystolon;" "Résumé of such Products as Sharpening Stones, Alundum and Crystolon for Polishing, Glass Cutting Wheels, etc;" "Edging Tools;" "Refractories." In substance some of these lectures were the same as those delivered last year with such addenda as had been secured from the experience of the past year.

While this school was conducted primarily for sober, earnest business purposes, entertainment and fun were by no means

lacking. Many pleasant gatherings of Norton men and visiting students marked the time outside of working hours. A most enjoyable outing took place at the home of the Tatassit Canoe Club on an island in beautiful Quinsigamond Lake. Then for a few hours the busy world and its troubles were forgotten.

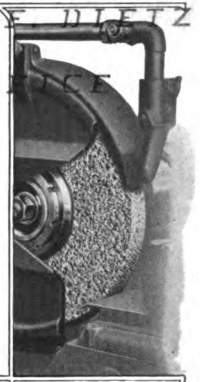
Those who attended the 1913 school, July 14-18, were:

The Canadian-Fairbanks-Morse Co., Ltd.,
Wm. Crozier, Montreal, Que., Canada
The Canadian-Fairbanks-Morse Co., Ltd.,
R. W. Cornish, Toronto, Ont., Canada
Carey Machinery & Supply Co., John H.
Orem, Baltimore, Md.
Chas. Churchill & Co., Ltd., John H.
Neal, London, England.
Cleveland Tool & Supply Co., O. F.
Bureau, H. B. Cole, Cleveland, O.
W. P. Davis Machine Co., Clarence F.
Kinney, Rochester, N. Y.
Erie Mfg. & Supply Co., W. M. Kreider,
Erie, Pa.
E. A. Kinsey Company, A. E. Douglas,
Cincinnati, O.
National Supply Co., Lee S. Davies,
Toledo, O.
Norton Company, Wm. Schwedler, Chi-
cago, Ill.
Pike Manufacturing Co., John B. Govan,
Pike, N. H.
Powell, Clouds & Co., Wm. B. Fisher,
Albert Townsend, Philadelphia, Pa.
S. M. Price Machinery Co., J. A. Beasley,
T. J. Pratt, Norfolk, Va.
Schroeter Bros. Hdwe. Co., Edw. Pender-
gast, St. Louis, Mo.
Simonds Mfg Co., Ltd., E. H. Stream,
New Orleans, La.
Smith-Winchester Co., Clarence J. Watts,
Jackson, Mich.
Somers, Fittler & Todd Co., Albert J. Loew
John Reber, Karl R. Stearns, Pitts-
burgh, Pa.
Vonnegut Hdwe. Co., H. Guy May,
S. Guy Provost, Indianapolis, Ind
J. T. Wing & Co., Fred J. McWilliams,
Geo. Stuart, James Stuart, Detroit,
Mich.



GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.



1913

AUGUST

1913



**Well Equipped Working Quarters of the Engineering Department of
Norton Grinding Company**



Grits and Grinds

Vol. V

August, 1913

No. 4

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Norton Roll Grinding Machine

**A Brief Description of a Machine that Sets a New Mark in Size and New
Records for Production and Accuracy in the Grinding
of Mammoth Rolls**

The Norton Grinding Company has designed and built a heavy cylindrical grinding machine to swing 54" in diameter and to grind rolls 18' in length and which has a capacity of 21' between centers. The machine can be furnished to take any desired length between centers.

Equipment

As will be noted from the illustrations, this machine is equipped especially for grinding heavy rolls but can be supplied without this special equipment, the machine then being suitable for grinding plain cylindrical work on centers up to its capacity.

Power

The machine is arranged for motor drive only, the equipment being as follows:

- 40 H. P. motor mounted on the wheel carriage for the revolution of the grinding wheel and wheel carriage traverse.
- 15 H. P. motor mounted on the headstock for work revolution.
- 2 H. P. motor on the footstock for traversing the footstock along the ways of the work base.

- 2 H. P. motor on the headstock for traversing the headstock along the ways of the work base.
- 2 H. P. vertical motor upon the wheel carriage for the pump revolution and traversing of the grinding wheel at right angles to the work.

Control

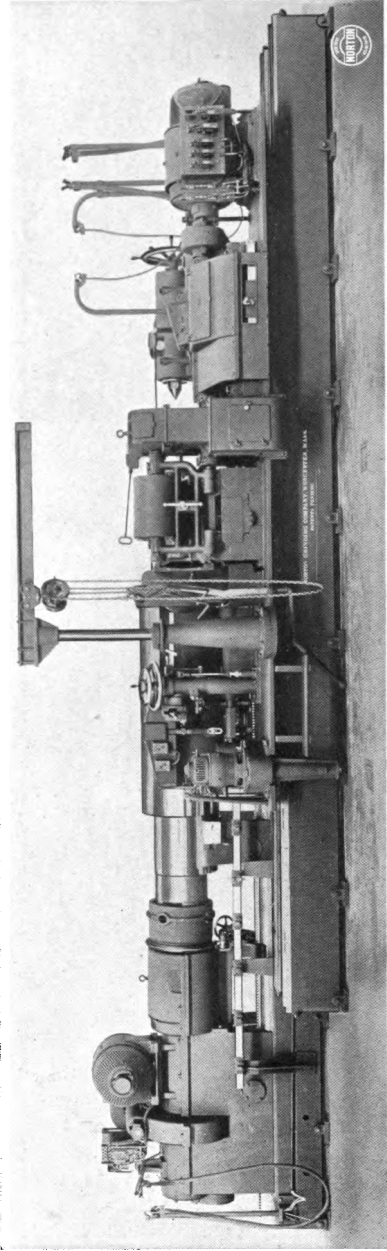
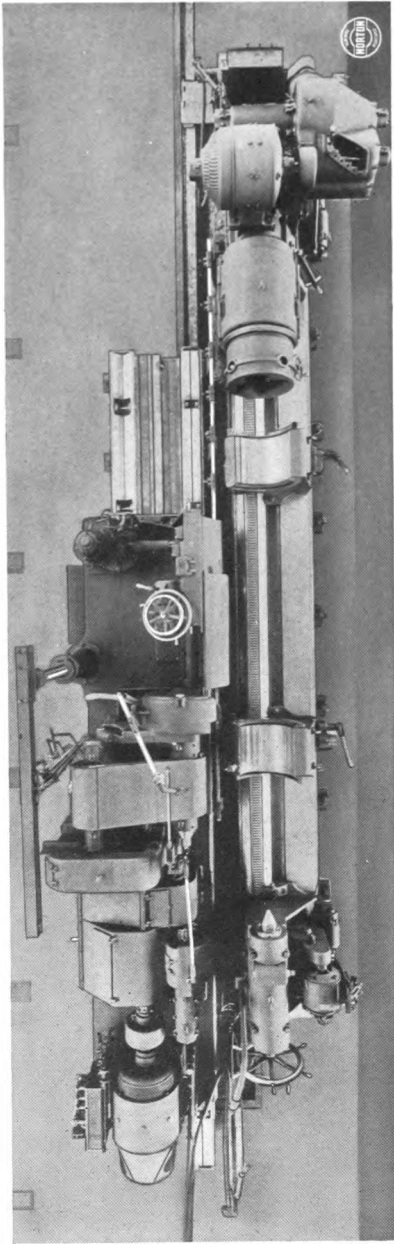
This machine is controlled from one position, the operator standing upon the wheel carriage beside the grinding wheel in such position that he can look directly down between the face of the grinding wheel and the face of the work which is being ground and can see what is taking place at the point of contact between the grinding wheel and roll. Standing in this position, the operator can reach all of the hand wheels and levers necessary for starting and stopping the wheel revolution, starting or stopping the roll revolution, reversing the traversing wheel carriage either by hand or by power, moving the wheel carriage for delicate adjustments by hand, moving the wheel to and from the work either by hand or by power, starting or stopping the traverse of the wheel carriage, changing from maximum to



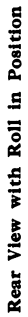
Referring to the illustrations, the operator uses the upper hand wheel for feeding the grinding wheel toward or from the work, one revolution of this hand wheel

moving the grinding wheel a distance of .040", corresponding to .080" reduction in diameter of work. If the grinding wheel is to be moved by power, the above hand wheel is disengaged by moving the lever at the right of the hand wheel toward the operator and locking the lever in this posi-

Plan View Made from Crane



Front View with Roll in Position
Norton 54" x 18' Plain Machine for Cylindrical Grinding

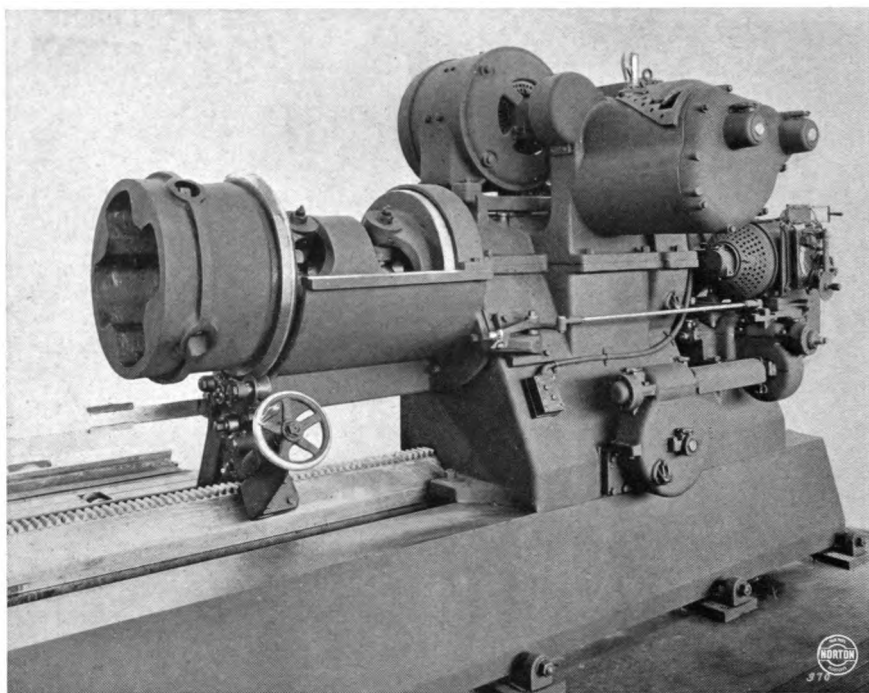




tion. This raises the hand wheel, disengaging it from the wheel feed mechanism and at the same time releases the wheel traverse lever at the lower left hand side. Moving the wheel traverse lever to the right or left operates a clutch, resulting in a movement of the grinding wheel either towards or away from the work. These levers are so constructed that the

upper position it engages the lower hand wheel with wheel carriage traverse mechanism, permitting movement of the wheel carriage by hand.

The changes in speed of work revolution are accomplished at the headstock with change gears. Intermediate speed changes for traverse of wheel carriage are made on the front of this carriage.

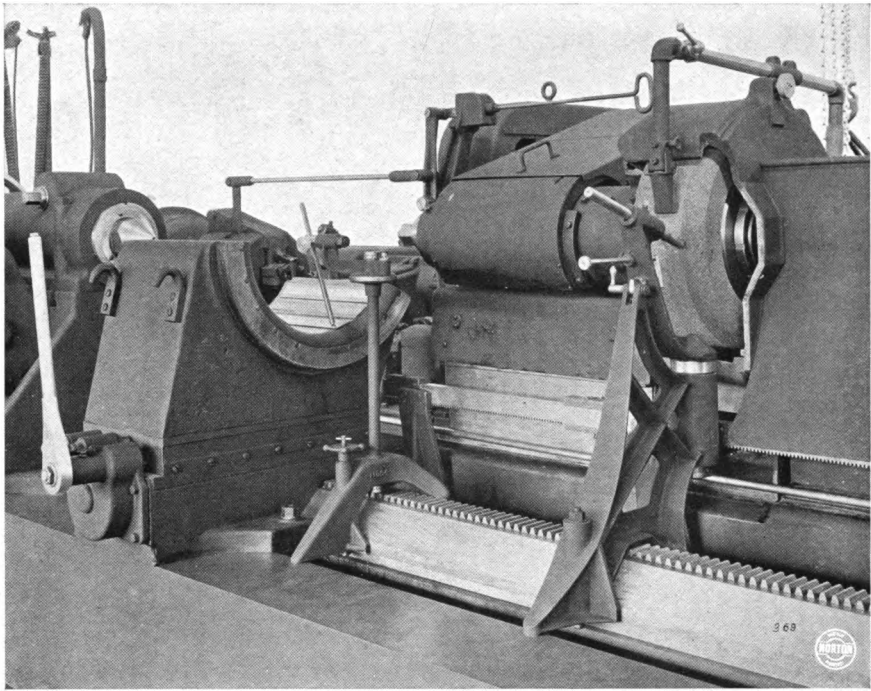


Headstock

power traverse cannot be thrown in until the hand wheel has been disengaged; nor can the hand wheel be engaged until the power traverse levers have been thrown out of engagement. The lever at the upper left hand side of the hand wheels controls the stopping, starting, and reversing of the wheel carriage. When automatic traverse of the wheel carriage is desired, this lever is placed in its lowest position. With the lever in the next higher position the wheel carriage can be reversed or stopped by hand. With the lever in its

Ways and Maintenance of Alignment

As this machine is designed for very large work it is imperative that the ways in which the wheel carriage travels, should be perfectly straight, and to obtain straight ways on this machine, the Norton Pendulometer is used. This instrument permits the detection of errors as small as .0001" at any point along the ways as related to parallelism and straightness of the ways. The ways are then scraped to master straight edges until the pendulum registers a straight line.



Journal Rest, also Trammel for Setting Bronze Shoes and Radial Truing Device

for correct alignment, that any error can be detected after many years of use.

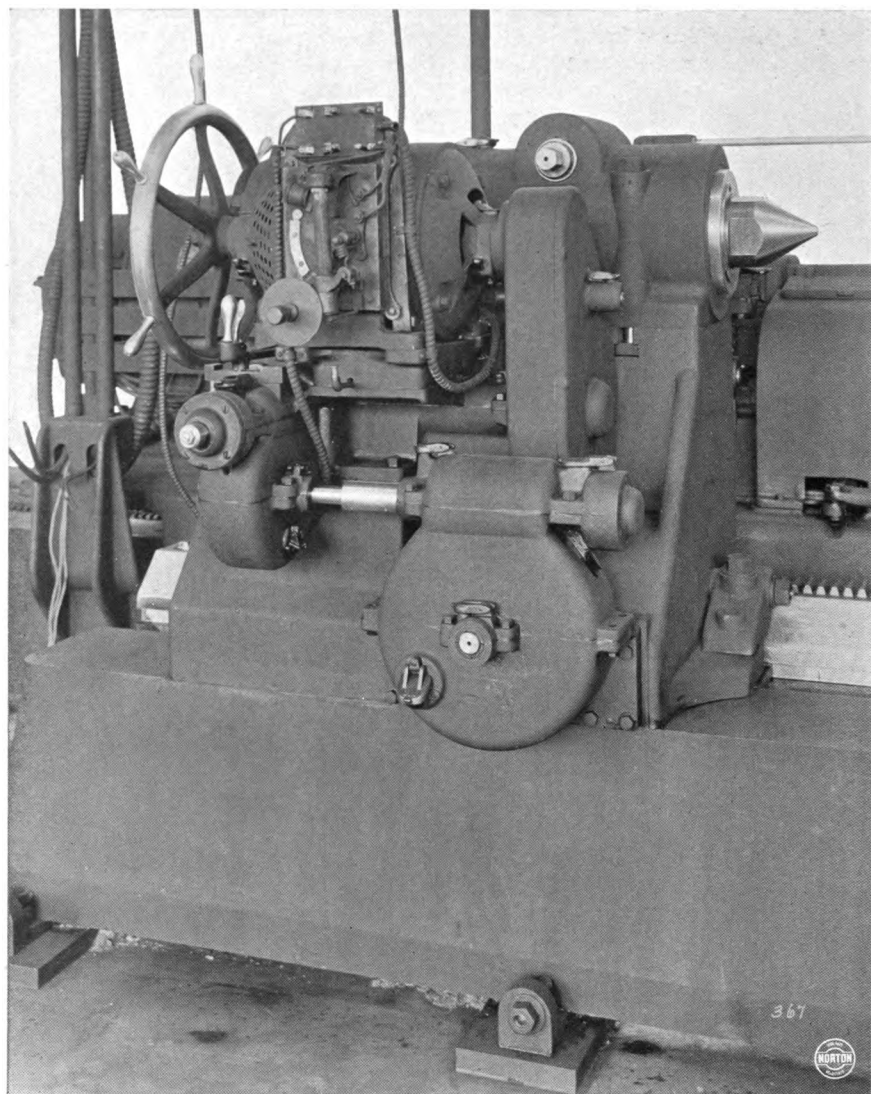
Single Wheel Design

Years ago Mr. J. Morton Poole invented the double-wheel machine with a swinging frame to secure accurate diameters over the entire length of the roll, for the reason that at that time there were no known methods to produce and maintain straight ways of sufficient accuracy to secure straight lines or uniform diameter of roll with a single grinding wheel.

sign it is possible to have the wheel large in diameter and of wide face, so mounted and provided with powerful drive as to permit the grinding, in a few hours, of rolls which formerly required a day or days for their grinding.

Further, it is more convenient to place heavy rolls in the machine, or remove them from the machine than is the case with machine equipped with the double wheel.

Under the old system a roughing cut was unknown. All cuts were practically



Footstock

finishing cuts, and hours, in fact days, were spent in the slow process of grinding with small wheels, not exceeding 14" or 15" in diameter and not over 1" or 2" in width, and relatively small spindles and frail supports were provided for the carrying of these wheels.

In designing this machine, the two objects in view have been accuracy and large production. The older line of double wheel roll grinding machines has produced accuracy at the expense of time. With the single wheel machine of modern design, advantage can be taken of greater



weight and power, securing accuracy and at the same time large production.

The first roll grinding machine of the type described in this article was shipped to a well known steel concern for grinding rolls to be used in the rolling of steel plate. The rolls are of various diameters and lengths, but the largest roll the customer expects to grind on this machine is 34" in diameter by 18' in length over all, although rolls 54" in diameter can be ground if desired.

It will be noted by reference to the illustrations, that the machine is equipped with massive pillow blocks and bearings for carrying the rolls upon their necks, the largest of these necks being 24" in diameter.

During the demonstration of this machine, rolls were ground in from one fourth to one half the time previously required for finishing the same rolls in the lathe. As yet there has not been sufficient time in which to definitely establish the conditions under which the machine will give the greatest output, but there is every reason to expect that greater savings will be shown after the machine has been longer in commission.

General Description

The original design of Norton Plain Grinding Machines has been departed from in this case, for the reason that the work to be ground is of such size that in order to see the point of contact between the work and the grinding wheel, it is necessary for the operator to have control of the machine on the same side of the work as the wheel is grinding. He does, however, as in the standard machine, have entire control of all of the important functions of the machine while standing in one position, and without reaching over the work.

To secure smooth work, the rolls are revolved through helical gears and large worm and worm wheel running in a bath of oil.

Six speeds of work revolution are provided.

The headstock spindle is 12" in diameter

the footstock spindle is 10" in diameter; the centers are 6" in diameter and are interchangeable.

When grinding rolls are carried on their necks, they are revolved by means of a large universal joint in order to give a steady and uniform rotation of the work, one end of the universal joint being bolted to the face plate of the headstock spindle. To the other end is bolted a driving sleeve which clamps solidly to the wabblor end of the roll, revolving as a part of the roll.

The driving sleeve and universal joint are made of steel castings.

When grinding work on centers, the universal joint, the universal joint case and the driving sleeve are removed and a driver is bolted direct to the face plate on the headstock spindle.

The wheel head with its spindle, wheel guard, wheel sleeve and wheel, weighs over 5,000 pounds and rests upon a solid wheel head base mounted on the long, heavy traversing wheel carriage, making it possible to grind the roll rapidly.

Provision is made for grinding the necks of the rolls either when carried on the machine centers or when the rolls are revolved upon their necks in specially arranged bearings, and machines can be supplied either with or without the footstock, the footstock not being necessary for grinding the roll necks, it being entirely practicable to grind rolls both on necks and bodies when carried in these specially arranged bearings. The pillow block bearings for use in grinding the necks are arranged with multiple bronze bearings which are adjustable for the small variation in the size of necks, a pillow block being required for each standard size, the adjustment taking care of the variation from the standard. Perfectly round necks are guaranteed whether or not there are centers in the roll. A trammel is provided for adjusting the roll neck bearings to correct diameter before the roll is placed in position for grinding, the design of this trammel being shown in one of the illustrations.



Fillets on the roll necks can be ground with the same wheel and at the same time as the necks are ground.

A forming attachment is also furnished, which is adjustable for any radius for the forming of the corner of the grinding wheel when fillets are to be ground.

A truing device is also furnished for truing the face of the grinding wheel.

The pump delivers about thirty gallons of lubricant per minute on the wheel and work.

The materials in this machine are the best obtainable. The castings contain about 20% steel, giving a very close grain casting of good wearing qualities. The wheel spindle is of the best chrome nickel vanadium steel, heat treated to a hardness which gives it extraordinary wearing qualities. The grinding wheel sleeve is a steel casting, as is also the wheel guard, this guard weighing over 600 pounds. The shafts are made of the best carbon steel and carefully ground to size. The worm and worm wheel are of first-class material for the purpose and are made by

Brown & Sharpe Mfg. Company. Helical gears in the headstock are of steel as are also many of the other gears in the machine, where strength and durability is required. All racks are of solid steel. The pillow blocks for roll necks are steel castings while the adjustable bronze bearings in these pillow blocks are of the best material obtainable. The adjusting wedges under these bronze bearings are of high-carbon steel.

All bearings, where necessary, are self-oiling. All oil holes are covered with a small iron cap which cannot be easily broken off, but is easily seen by the operator. All oil holes are of ample size.

When desired, an attachment can be supplied for this machine, which will permit the grinding of rolls with either a concave or convex face. The machine as shown in the illustrations is arranged for grinding rolls either straight or with straight tapers, whether or not the rolls are carried on centers when being ground.

The machine, as illustrated, for grinding rolls, weighs about 100,000 pounds.

Where Norton Grinding Machines are Designed

**The Engineering Department and its Drafting Room Where Were Produced
More than 6,000 Drawings for the Machine Described in this Issue**

On the front cover of this issue is an illustration of the working quarters of the Engineering Department of Norton Grinding Company. The first glance at this illustration shows how effectively the room is lighted. The larger part of the room is indirect diffused daytime lighting secured by a northern exposure. The walls are tinted in a color which absorbs most of the eye disturbing rays. Each board has its own lights for work. Each board is equipped with the latest type of Universal drafting machine. Throughout the room are found the modern ap-

pliances needed by a truly efficient engineering staff.

One feature which is particularly useful is the large demonstration board, where either the full size parts or full size machines can be laid out. The reader can readily appreciate that to design machines so accurate as the modern grinding machine with so little fundamental data as is available for such designs requires a working staff of demonstrated ability. It is probably true that one-third of the men shown in this illustration spend all their time solving customers' problems; the



designing of special attachments which help them overcome their grinding difficulties. As a matter of fact, the men of the engineering staff are necessarily chosen with a view of obtaining men with sufficient "gray matter" to independently solve ordinary grinding problems. There

are few parallels in machine tool building for the present situation in the grinding machine field. It is a case of constant study, constant experiment, constant development and a high average of well-earned achievement.

Alundum Refractories in Special Shapes

That Alundum, long known as an abrasive of the highest quality, possessed properties that would permit of its being made up into shapes suitable for withstanding extremely high temperatures was a discovery which brought about the man-

ufacture of Alundum refractories and laboratory ware as an addition to the many other forms in which Alundum is employed in the manufacture of Norton products. Thus, we have such refractory articles as electric furnace cores, muffles,



Regular Shapes of Alundum Refractories



tubes, plates and tiles suitable for the construction of furnaces whether the newer type of electrically heated or the older forms (many of which are in use at present) heated by gas or oil; crucibles for the ashing of organic materials and combustion boats for the determination of carbon in iron and steels.

Later it developed that because of the peculiar shape of the grain, Alundum could be bonded and made into shapes especially adapted to the filtration of various solutions. In the line of laboratory ware and small refractories, there are the filters which are playing a very increasing part in the industrial laboratory and in commercial operations; crucibles and cones

for quantitative determination of the elements and other compounds; dishes and plates for the commercial filtration of liquids; extraction thimbles now used extensively in the estimation of fats and oils in foods, soaps, etc.

Long practice in the construction of special shapes of this material enables our workmen to turn out good work both regular and special which, in conjunction with our increased knowledge of the conduct of Alundum refractories in actual service, enables us to produce bonded shapes of Alundum for use in refractory problems involving furnace, analytical chemistry, mechanics and the other allied sciences.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Springfield Mfg. Co., Bridgeport, Conn., has brought out a new line of wet and dry ball-bearing grinding machines. Specifications and illustrations appear in the Iron Age, July 24th, 1913—page 176. Iron Trade Review, July 24th, 1913—page 172. American Machinist, July 24th, 1913—page 163.

Harper, Sons, & Bean, Ltd., Dudley, England, are introducing a ball-bearing ring wheel grinding machine carrying a 16" ring wheel. Illustrated and described in European edition of American Machinist, July 19th, 1913—page 168E.

A recent product of the Woods Engineering Co., Alliance, O., is a universal tool and cutter grinding machine. American Machinist, July 17th, 1913—page 121.

Cincinnati Milling Machine Co., Cincinnati, O., are building a new cutter grinding machine. The centers swing 10" in diameter by 17" long. Full details and

several illustrations are found in American Machinist, July 10th, 1913—page 59.

A table for use when grinding tapers is a contribution by Wm. Henchen, Urbana, O., in American Machinist, July 13th, 1913—page 72.

E. H. Brooksucker describes a novel method of grinding gears in the European edition of American Machinist, July 5th, 1913—page 994.

A device for supporting slide rest grinding attachment used in a bench lathe is described in American Machinist, July 10th, 1913—page 71.

Special cam grinding machine used by Reo Motor Car Co., Lansing, Mich., is described and illustrated in the European edition of American Machinist, July 19th, 1913—page 1066.

"The Grinder in Gas Engine Work"—a description of special applications of disc grinding machine appears in American Machinist, July 3rd, 1913—page 21.

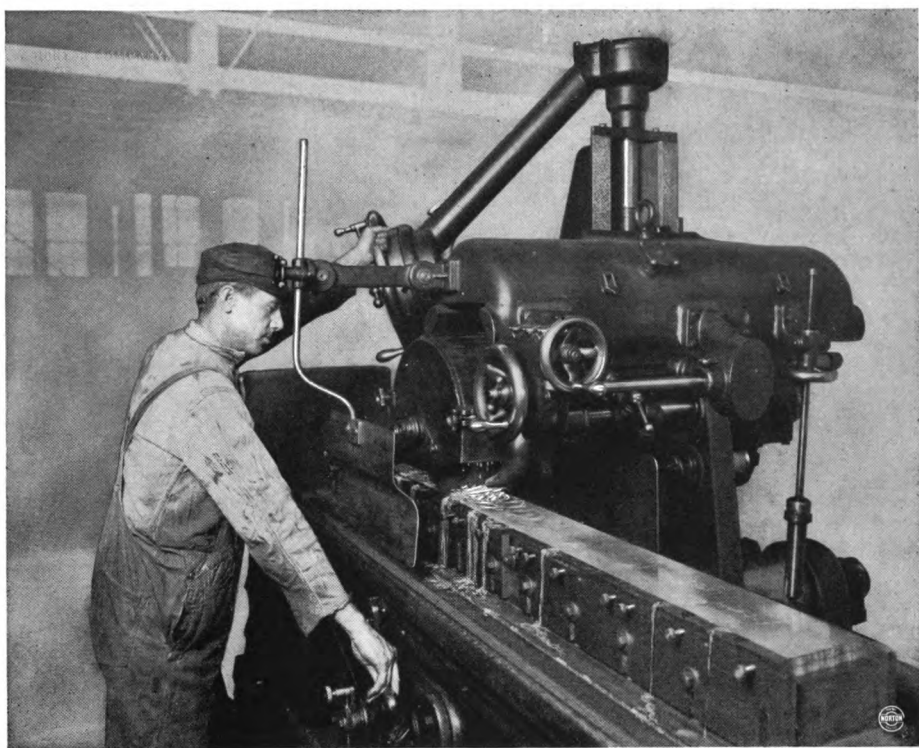
GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

SEPTEMBER

1913



**Open Side Norton Surface Grinding Machine with Special Fixture to Grind
Edges of Square Blades for L. S. Starrett Company**



Grits and Grinds

Vol. V

September, 1913

No. 5

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Grinding Wheels in the Foundry

Some Notes on Cost Per Unit of Production—Productivity Per Unit of Time—Relation of Wheel Speed to Production—and a Discussion of Wheel Life and Productive Ability

BY CARL F. DIETZ

In this era of industrial development in which achievements are recorded not even dreamed of a few years ago, it is but natural and necessary that fundamental scientific principles, based on Nature's laws, should be applied to our commercial production.

Curiously enough the thoughts of investigators and the disciples of the principles of commercially applied science, not to use the term efficiency with which the latter-day technical press has been saturated, turned first in the direction of the more refined mechanical operations; possibly because of the improvement that seemed obvious and probably because of refined mechanical operations being of newer origin and therefore not as yet necessarily adopted as definitely accepted methods because of long usage.

However that may be, recent experience in this new branch of engineering clearly shows the possibilities even in the rougher and well established operations, and the purpose of these notes is not to apply complex mathematical equations to the use of a grinding wheel, but to point out those underlying principles which must

be considered if the best possible results from the use of this modern cutting tool are to be obtained.

In view of the growth of the metal working industry and the development of alloys of steel and iron that cannot be commercially worked with the usual tools, it becomes all the more important that the functions of the grinding wheel so universally employed in foundry work be more fully appreciated.

Naturally, every user of grinding wheels desires the particular kind of wheel which, based upon the abrasive material, grain and grade combination, turns out his work most rapidly and at the least cost. To determine this implies in many instances an investigation of comparative merits by actual test. So that the results of such tests may be accepted as a true measure of the merits of the wheels under consideration, the conditions governing the tests must necessarily be comparable. We have two main elements to consider—the mechanical and human. Of these two, of course, the latter is so extremely variable that constancy can only be approached and the law of averages must



be applied. Under the mechanical factors we have the important items of machines; speed; uniformity in class of work; material to be removed, both form or shape, and quantity. Among the standards of comparison may be enumerated the following:

- (a) Mounting on same machine, or a machine in practically the same condition.
- (b) Speeds uniform and comparable in both cases.
- (c) Work of same class and character.
- (d) Same operator employed.
- (e) Freedom of prejudice on part of operator.

Frequently it is found that purchasers estimate the quality of wheels on the basis of the number of operating hours required to wear them down a certain number of inches on the diameter with or without recognition of the tonnage handled.

Recently an extensive series of tests clearly indicated that the comparative merits of wheels cannot be estimated on life without due consideration of tonnage ground, and the ultimate basis of comparison should of course be the cost per unit of tonnage ground, which, if machine costs are all practically alike such as up-keep, power, etc., resolves itself into a comparison of wheel life based on its original cost, tonnage, and wages paid in producing that tonnage.

There has been and still is a tendency on the part of the buyer to demand long life for the wheels, unduly emphasizing that point while manufacturing departments are primarily interested in production. It is manifestly more economical to use a wheel capable of producing a greater tonnage in less time, even though the wheel wear has increased proportionately. Hence tonnage is an important consideration in estimating wheel economies. As a general rule ability to cut freely and life vary inversely with each other. The characteristics it is therefore necessary to impart to a wheel are a maximum productive ability per unit of time with a minimum shrinkage in wheel diam-

eter, the limit, of course, being that degree of hardness which calls for excessive exertion and too frequent dressing.

It is interesting to note the performances of a series of wheels, each group representing six or more, showing varying cutting qualities:

Total Hours	Aver. Hours	Total Tonnage	Aver. Pounds per Hour
85-100	92	15,240	155
100-120	110	18,914	172
120-140	132	22,011	166
140-160	146	23,990	164
160-180	165	27,532	166

When reducing the life and total tonnage to the unit of time basis the characteristics of the wheels are more clearly revealed, it being assumed of course that all pieces of work were practically alike so that the amount of actual material removed bore a more or less constant ratio to the weight of the pieces themselves. From these figures no definite relationship can be established between tonnage per hour and wheel life, the former being fairly constant and the differences in wheel value being almost entirely confined to wear per unit of output. The rate of wear is largely dependent upon the operator and this latter is the most variable factor in the equation.

Perhaps the above record is an explanation of why the thought of life in hours is so frequently used as a measure of wheel value. This table shows that the wheels of longest life are the most economical even though their output per unit of time is a shade lower than one of the other groups. We have here the ratio of approximately 55% greater life with only 3.6% greater productive capacity per time unit.

This is not always so, however, as evidenced by the following record and if life alone were considered it would militate against industrial economy.

Life	Total Tonnage	Aver. per Hour
127 hours	26,543 pounds	208 pounds
157½ " "	27,043 " "	172 " "

Analyzing these figures, the two wheels earned practically the same amount, but the greater speed of work production per



unit of time gives the shorter life wheel the advantage not in actual total output, but in productive capabilities of the installation which must necessarily interest any shop manager.

In this case the earnings per wheel per hour on 2 mills per pound piece-work rate is 41.6 cents and 34.4 cents respectively, or 20.5% in favor of the shorter life wheel, while the earnings for the total life of both wheels are \$53.08 and \$54.08 respectively, a difference in favor of the longer life wheel of only about 2%.

These are points that are apt to be overlooked by the wheel purchaser, making it often impossible to intelligently and dependably estimate wheel values unless all the figures are analyzed.

Among the factors exerting a potent influence on the performances of wheels, we find that of speed, the importance of which seems to be not fully realized. At times it is reported that a wheel is below some other wheel in point of output and life, when an investigation may show that comparison has been made between wheels of different diameters and while the revolutions per minute may be alike the peripheral speed is quite different. It is this latter factor which may be said to be a life-giving quality of the wheel. A maintenance of proper speed means much to the productive capabilities of a wheel.

An 18" wheel at 1280 R. P. M. moves with a peripheral speed of 6000 feet. At 15" diameter and same R. P. M. the surface speed is but 5000, while at 12" it has dropped to 4000.

The peripheral velocity at all times varies directly as the diameter under constant speeds. That is, the velocity at which the face of the wheel travels, when the number of revolutions per minute remains constant, grows less as the diameter decreases; hence when the wheel is only five-sixths of its original size, the surface speed will be only five-sixths of that which it was when the wheel was mounted, and when the diameter is down to two-thirds the original, the sur-

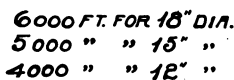
face velocity will also be but two-thirds of the original.

When a grinding wheel acts upon a piece of metal forced against its face, it is called upon to do work, or expend energy. This energy is supplied by the power given to the spindle and is taken up largely by the resistance the work offers to the abrasive particles on the face of the wheel acting as cutters. These particles cut loose a given piece of metal which leaves the point of contact at a tangential line of the wheel. At the same time the resistance of the metal causes the abrasive particle to be worn down by breaking off a piece of it, or indeed if the cutting edge of the particle in question has become very dull, the resistance of the metal may tear it out of its setting, exposing a fresh, sharp particle which can do the work.

All this requires energy, which is the work stored in each particle of abrasive grain and capable of performing work. This energy factor is proportional to the square of the velocity with which the body travels, hence the power to do work falls off more rapidly than merely the difference between surface speeds at varying diameters. It is not so difficult then to understand why the complaint is frequently made that a wheel has diminished in productiveness toward the center and appears soft.

Consider for a moment diagram No. 1.

The cutting teeth when in contact with the work at A have a certain energy stored up in them due to their mass and speed of travel. This energy is used in part to cut chips, and since this energy as shown by the expression in the diagram is proportional to the square of the velocity, it falls off as the diameters shrink to 15" and 12" in the proportion of 36 to 25 to 16. These latter figures represent the squares of the peripheral speed. In other words, when the diameter of the wheel has become 15", the energy stored up in the cutting tooth is but 70% of that at 18", and when 12" diameter is reached the energy is less than half of that at 18", or but 44.5% of the original.





up again at 15" diameter and 12", they would undoubtedly have shown more nearly straight lines and their life proportionately increased. The inclination of the lines to the horizontal measures directly the rapidity of wear and the more acute this angle, the more rapid the loss of wheel diameter.

18" diameter were speeded up to 6000 surface feet initial speed and maintained, with the result of over 100% increase in output during the life of the wheel. This is, of course, an extraordinary result but indicates the possibilities of higher speeds and their maintenance under some conditions.

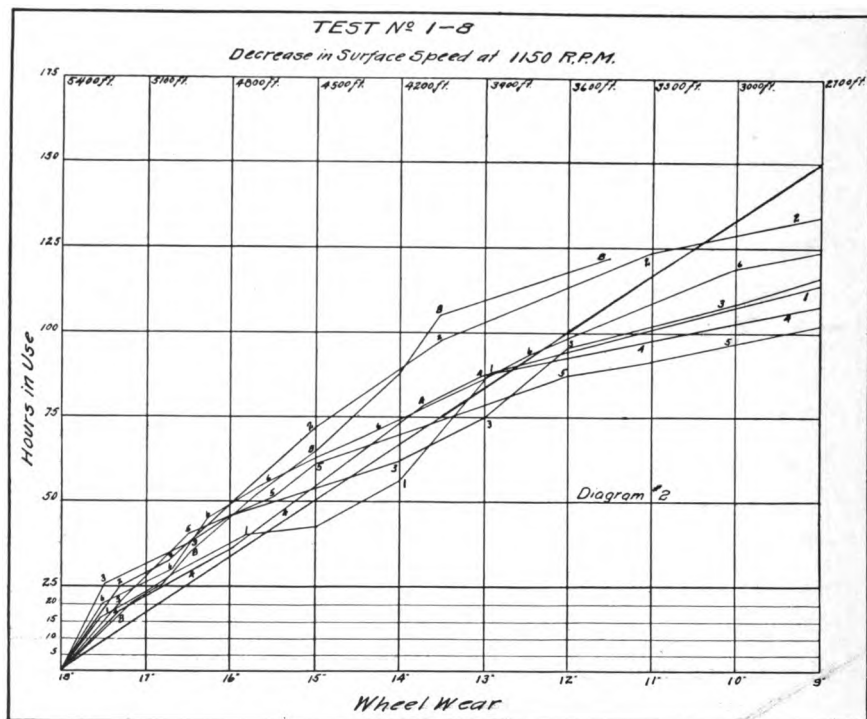


Diagram No. 2

Increased production is unquestionably to be expected from an increase in speed, because of, first—the greater energy and consequent cutting ability of the grain particles; second—the more frequent cuts per unit of time of each grain; and third—the harder action of the wheel, or better the greater holding power of the bond.

One instance of increased production due to increased speed may be mentioned. Wheels that had been operated at an initial speed of 5000 surface feet at full

It must be borne in mind, however, that a wheel selected to do a certain piece of work, at, say, 5000 initial surface feet, will not, if it is already at the limit of hardness, necessarily operate satisfactorily at 6000 surface feet per minute. A change in grain and grade combination may be necessary and the higher speeds should be employed only when the machines are in good condition, and provided with proper protection hoods.

The above considerations prompted



some investigations, the results of which are sufficiently interesting to record, and are in support of the thoughts expressed.

One of the first questions that would naturally suggest itself in connection with greater wheel speeds is that of power. How does this vary with the greater production per unit of time? The following

Differences (increase)

1000 .17 .22
or 20% or 8.12% or 18.05%

From this it will be noted that the stock removed per unit of time increases in a ratio at least approximating the speed increase, which latter is a direct measure of the increased number of cuts each grain

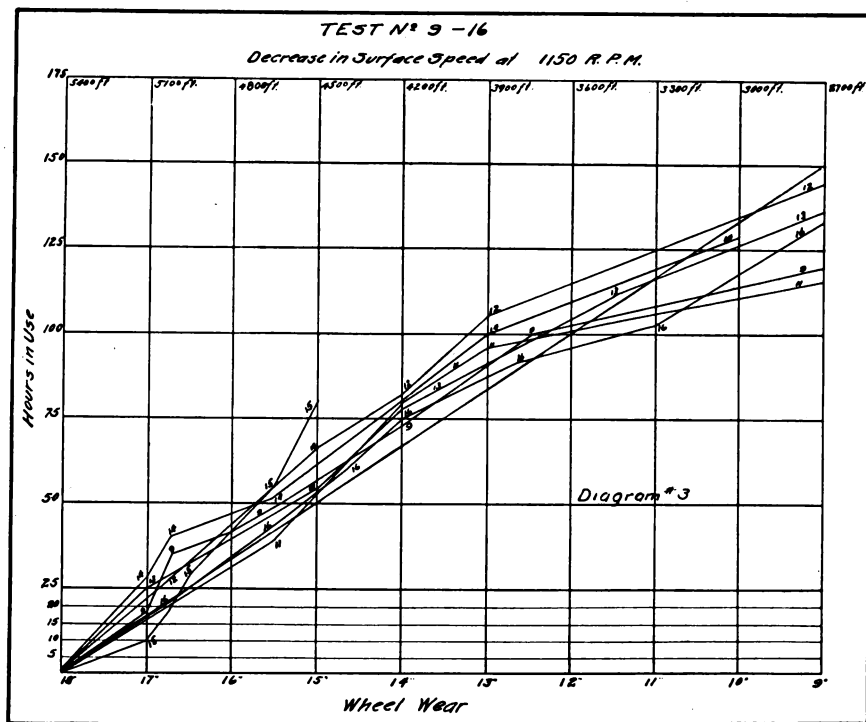


Diagram No. 3

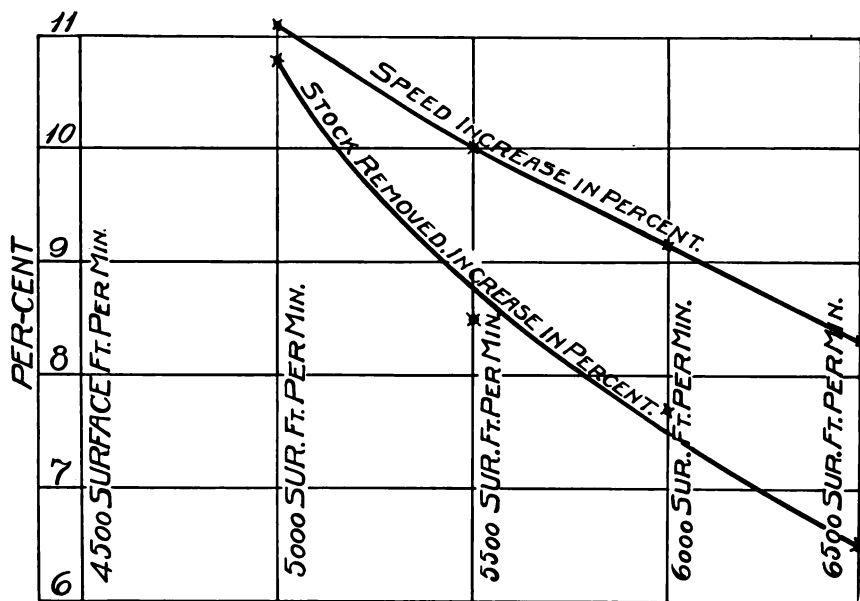
test is indicative of what might be expected.

An 18 x 2 x 1½", grain 10, grade W, Alundum vitrified wheel was tested at two speeds on manganese steel. All conditions, except the speeds, were comparable in the two tests. Results to be recorded are:

	Surface Speed in Ft. per min.	H. P. for Cut	Cubic Inches Material Re- moved in 5 min.
Test No. 1	5000	2.09	1.22
Test No. 2	6000	2.26	1.44

makes in a given time. Wheel wear, on account of short duration of tests, was not measurable.

The power as given is that actually required to do work in grinding, the friction load of machine, shafting, etc., having been subtracted from the total in both instances. That certain limiting factors must be recognized has been suggested, and any one given wheel cannot be expected to indefinitely respond according to theoretical considerations.



SURFACE FEET PER MINUTE
DIAGRAM N^o 4.

That productiveness is increased with speed is shown by a further test, but the ratio is not direct and becomes even less so at the highest speed, since such factors as the crushing strength of the grain itself become more important, and also the size of each individual chip decreases with the higher speeds.

A series of two-minute tests with a grain 16, grade O, vitrified Alundum wheel on lead-screw steel resulted in the following record.

Surface Speed in Feet per Min.	Per Cent. In- crease	Cubic Inches Stock Removed in 2 Min.	Per Cent. In- crease
4500		1.11	
5000	11.1	1.23	10.8
5500	10.	1.335	8.53
6000	9.09	1.44	7.85
6500	8.33	1.533	6.45

Diagram No. 4 graphically represents the effect of these higher speeds and clearly shows that even though the output of a wheel is not in direct proportion to the speed increase, it does not fall so far short and may in many instances be an important consideration.

These tests were extended to 6500 surface feet merely to note the action, but a wheel which will do satisfactory work at say 5500 surface feet is almost certain to act hard at this high speed.

The art of wheel making, as many other industries, has developed along scientific lines, and even under the usual rough snagging conditions in the foundry, wheel speeds of 6000 surface feet per minute have been found permissible. It is of course to be emphasized that the machines must be in good mechanical condition and provided with substantial protective devices. The fact that the value of higher speeds for foundry grinding is recognized is evidenced by the notation now appearing on Norton Company's wheel tags, where for all wheels of the usual grain and grade combination, as used in the foundry, two speeds are entered equivalent to from 5000 to 6000 surface feet per minute. It is obviously then for the operator to determine as to whether his equipment will permit of the higher rate in addition to the requirement of his work, and be governed accordingly.

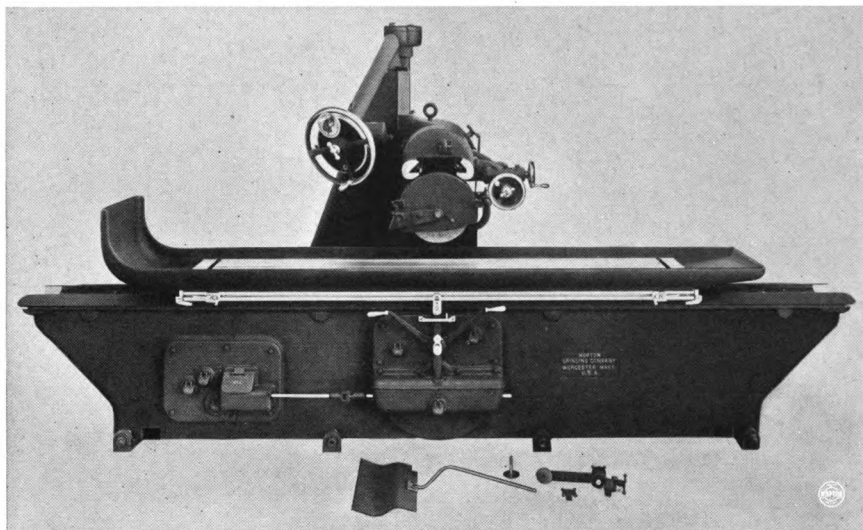


Open Side Norton Grinding Machine for Plane Surfaces

BY CHARLES H. NORTON

The working surface of the table is 15" wide and 6', 8', 10', 12', and 14' long, depending on the length of machine. This entire surface can be ground in place. The wheel head can be raised to give a distance of 17" between the surface of the table and a 14" diameter wheel, thus making provision for use of magnetic chuck or supplementary table.

plane surfaces as the arc of contact in that case is much greater than when round work is being ground. For the same reason we use the periphery, not the side of the wheel, as with the side of the wheel (ring wheel), or with large arc of contact of the periphery there is not the same opportunity for the chips to escape. When for any reason the chips



Open Side Norton Grinding Machine for Plane Surfaces

The machine is designed to carry wheels 14" in diameter and for the ordinary line of work the wheel would be 6" face. For special work, wheels of different widths can be furnished.

Experience has taught us that with grinding wheels the smaller the arc of contact the more efficient the wheel becomes. We therefore advocate the use of wheels of small diameters. This is especially necessary when grinding

cannot escape freely a neat appearing finished surface cannot be produced.

For these reasons we use on this machine the periphery of as small a wheel as is practicable.

A countershaft is located in the machine base, making the machine self-contained, and power is transmitted to this countershaft through a belt from a motor placed at the side of the machine. All overhead works are eliminated.

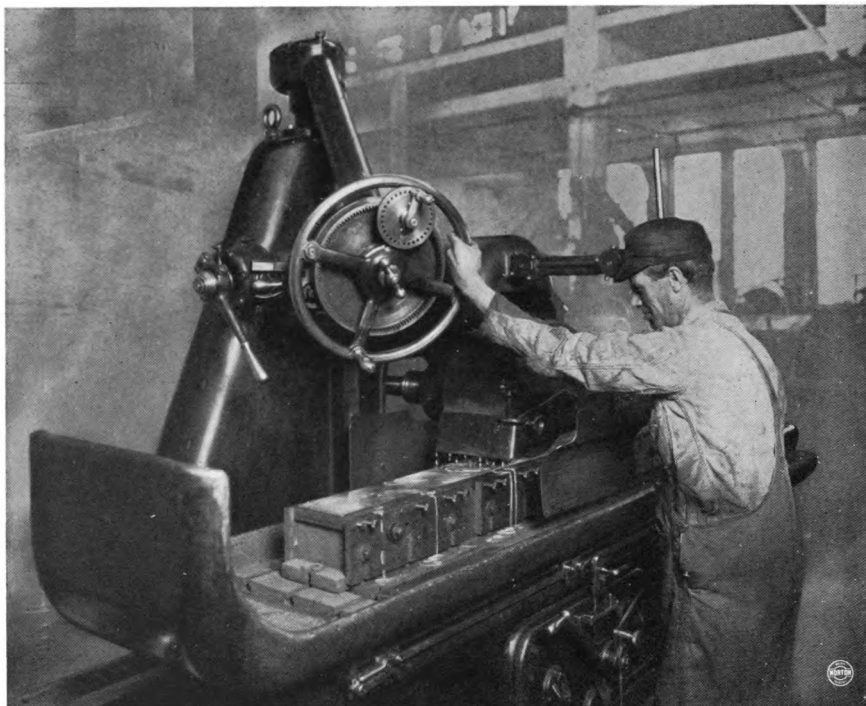


For ordinary work a 15 h. p. motor will be satisfactory.

The grinding wheel is carried on a cross slide operating at right angles with the travel of table, and in order to secure the large production that is made possible by the use of the wide wheel, no automatic feed of the wheel has been provided, a

vertical traverse screw, and a micrometer index, which registers in one quarter thousandths, provides for delicate adjustments.

The table is provided with Tee slots of standard dimensions, which facilitate the strapping of work directly to the table or the application of a supplementary



Another View of Norton Surface Grinding Machine Especially Equipped to Grind Starrett Square Blades

hand traverse having been designed for locating the grinding wheel so as to utilize the full width of wheel face. Provision is also made through worm gearing for the slower traverse of the wheel when truing the wheel face. The cross slide is carried in a vertical slide which is designed for raising and lowering on the column by means of a $\frac{1}{2}$ h. p. motor through a lever and friction clutch. For small distances the vertical traverse is obtained by means of a hand wheel on a shaft geared to the

table, special fixtures, or magnetic chuck. The table traverse is obtained by means of worm gearing of the most approved type, thereby giving the table a perfectly smooth motion which is absolutely essential for the production of a smooth and accurate surface on the work. The reversal of the table is pneumatically cushioned at the ends of the stroke.

All kinds of plane surfaces, which are within the capacity of the machine, can be ground quickly and accurately. The



machine can also be used for grinding a variety of shape surfaces, for which class of work a special forming attachment is used to form the wheel face to produce the shape required.

Ball bearings are employed on all shafts operated by hand wheels, and worm and worm wheel shafts are provided with ball thrust bearings, and all worm gearing runs in an oil bath. Worms and wheel spindle are made of chrome nickel vanadium steel, heat treated, and all shaft bearings are ground and run in self-oiling boxes. Special equipment is used in the scraping of the ways in the base, resulting in such accuracy of alignment that when the table has been ground in place, it presents a neat and uniform surface, free from chatter marks, and our inspection requires that a B. & S. straight-edge the length of the finished table surface shall hold tissue papers 2" apart throughout its length at any angle on the table. The machine is supported on ad-

justing wedges resting on iron plates which are imbedded in a concrete foundation, making it possible to easily realign the machine, should occasion require. A large water tank is provided with a pump which will deliver 30 gallons of lubricant per minute on the wheel and work.

With the standard machine will be included one grinding wheel; one wheel sleeve; all belting, including the main belt from the motor; a suitable equipment of wrenches; oil cans, etc. Also, the $\frac{1}{2}$ h. p. motor for wheel head traverse. The 15 h. p. motor and electrical equipment for same are to be furnished by the customer.

Size	Approximate Net Weight
15 x 17 x 6'	14,000 lbs.
15 x 17 x 8'	15,500 lbs.
15 x 17 x 10'	17,500 lbs.
15 x 17 x 12'	20,000 lbs.
15 x 17 x 14'	22,500 lbs.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A bench-lathe grinding attachment with automatic feed is described and design of its parts reproduced in *American Machinist*, August 21st, 1913—page 325.

Landis Tool Co., Waynesboro, Pa., has developed a large roll grinding machine which is also adapted for other cylindrical work. Described and illustrated in *American Machinist*, August 21st, 1913—page 331 and 332.

An electric grinding attachment for lathes is a new product of Forbes & Myers, Worcester, Mass., and is shown mounted in two different ways in *American Machinist*, August 21st, 1913—pages 332-333.

The Woods Engineering Co., Alliance, O., has recently brought out a universal

tool and cutter grinding machine designed to meet the requirements of tool room grinding. *Machinery*, August, 1913—page 999; *Iron Age*, August, 14th, 1913—page 386.

Sterling Grinding Wheel Co., Tiffin, O., has brought out a double-end wet tool grinding machine especially adapted for small tool work, and typewriter and similar processes of manufacturing. *Iron Age*, July 31st, 1913—page 254.

A plain grinding machine which is understood to be the largest grinding machine yet built in which the work is carried on a moving table past the grinding wheel, a recent product of Churchill Machine Tool Co., Ltd., Manchester,



England, is described at length in American Machinist, July 31st, 1913—page 181 and 183.

The Brandes Wet Tool Grinder has been placed on the market by Springfield Mfg. Co., Bridgeport, Conn. Two views, one with individual motor drive, are shown in Machinery, August, 1913—

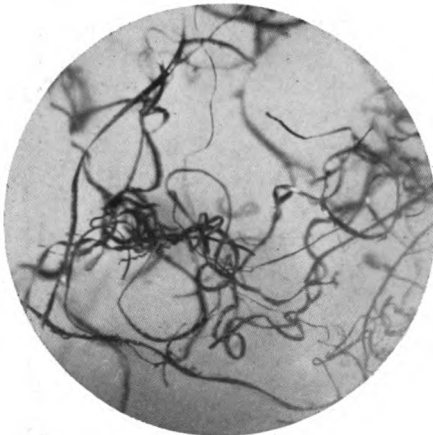
page 989-990.

Springfield Mfg. Co., Bridgeport, Conn., have added to their line a new type of dry grinding machine, equipped with ball-bearing so designed that it will be difficult for any dirt or grit to find its way into the bearing. Machinery, August, 1913—page 992-993.

Specimens of Chips Produced in Vertical Spindle Surface Grinding Operation

The success of any grinding operation depends upon having the proper wheels for the work to be ground. For every material which is ground there is a certain

Vertical Surface Grinding Machine in the works of the Westinghouse Machine Co., East Pittsburgh, Pa. The same wheel, a No. 3816, Grade H, Alundum Silicate, was



From Rex AA High Speed Steel

abrasive, a certain combination of grains, and a certain grade of resistance of the bond to fracture which will make for maximum efficiency in grinding.

A good indicator of the action of a grinding wheel can be found in the chips produced by the wheel. By means of a microscope we find that the small particles of "dust" are in reality metal chips, as clean cut and curly as are obtained from a lathe or planer tool.

The accompanying photomicrographs show chips made by a Norton Wheel.

The operation was the surfacing of two different steels on a Pratt & Whitney



From Soft Machinery Steel

used in both cases. The magnification is 10 diameters.

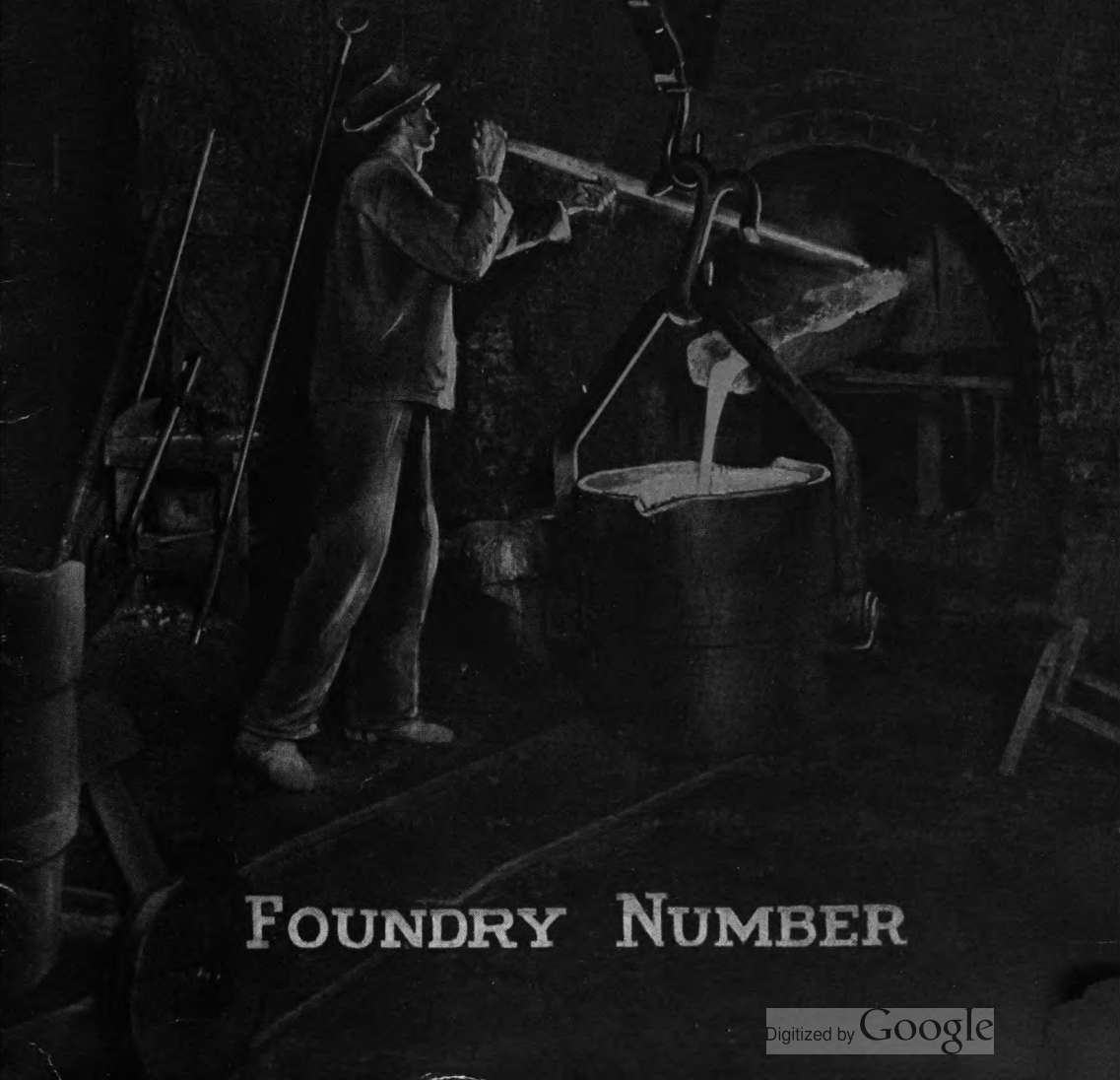
Fig. I shows chips of Rex AA High Speed Steel. Note the resemblance to lathe chips. That the wheel was cool and free cutting is evidenced by the absence of small, round globules; that the wheel was not too soft is shown by the absence of abrasive particles.

Fig. II shows chips of soft machinery steel. That the right wheel was used in this case is likewise shown by the absence of round globules and particles of abrasive.

These two cuts are good examples of the right wheel for the operation.

GRITS and GRINDS

OCTOBER 1913



FOUNDRY NUMBER



Grits and Grinds

Vol. V

October, 1913

No. 6

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Grinding Castings

Importance of Grinding in Cleaning Castings. Types of Machines in Use. Protection Appliances. Mounting. Spindles, Flanges, Washers, Bushings. Factors which Govern Selection of Grain and Grade

Castings must be cleaned. Unless they have been cleaned, it is not to be expected that a number of pieces which have been cast in sand will fit together. The adhering sand and scale can be removed by means of a sand-blast, but the most practical and efficient method of removing fins and sprues is with a grinding wheel.

The grinding of castings demands more thought and attention than any other branch of the cleaning operation. When selecting the wheel, machine and method, careful consideration must be given to the size and shape of the casting, and kind of material, as castings vary to a large extent—from small malleable iron pieces weighing a fraction of a pound to rolling mill gears of manganese steel weighing tons. There is a wide variation in weight in both steel castings and cast iron castings. While some malleable iron castings are medium heavy, most castings of this metal weigh but a few pounds. As a general rule, brass and bronze castings are light in comparison with the average steel castings and aluminum castings are

bulky, but their weight seldom runs above fifteen pounds.

Castings varying in weight from a few pounds to about 75 lbs. are usually ground on floor stands or disc grinders, while those weighing more than 75 lbs. are ground by means of swing frame machines or flexible shaft grinders, in many instances it being found more convenient to move the grinding wheel over the casting than the casting over the grinding wheel.

All floor stands have work rests as part of their standard equipment and the casting is usually supported on the rest while being ground. Some castings are of such shape, however, that it is not practical to use the regular work rests. A chain from an overhead trolley or from a girder offers convenient method of supporting such castings.

Disc grinders are usually equipped with special adjustable fixtures and are used mostly where the style of casting runs uniform. Various devices are used in connection with swing frame machines for holding the work, such as a heavy

Grinding
Machines

Cleaning by
Grinding



wooden block, a pit in the ground, a raised platform which brings the surface to be ground up to such a level that the operator can get the best possible purchase on the machine; or, in cases where the casting weighs three hundred pounds or over, it is wedged upon a heavy two-wheel truck and moved under the wheel for grinding. Flexible shafts are held in the hand. Such a small amount of pressure is brought to bear upon the piece being ground that simply laying the casting on a bench or on the floor is sufficient.

Still another class of machines is in common use for grinding the kind of castings that cannot be worked with metal tools and yet must be finished to fairly accurate dimensions. These are the alloy steel castings, the most common of which is manganese steel. The machines commonly used for this class are the lathe, boring mill, shaper and planer.

Work ground in the lathe is supported between centers bolted to a face-plate or held in a chuck. The grinding wheel is mounted on the tool carriage and the operation is usually performed dry.

Boring mills are used for such large castings as manganese steel safes and it is quite common to have two wheels operating at once, one on the outside and the other inside the casting.

A shaper is quite frequently converted into a grinding machine by mounting a cup-shaped wheel in inverted position on a vertical spindle at the front end of the ram. A common operation is grinding slots in some large casting.

The most common method of converting a planer into a grinding machine is to mount an electrically driven tool-post grinder on the cross-rail.

The tendency of the times is toward individual motor driven machines, but it is very common practice to drive machines used for snagging castings from a main line shaft. Where grinding machines to be kept in continual operation, the group method of driving would probably be the most economical, but it is often necessary to stop a number of machines in

a row, and if the machines are driven by individual motors the power load can be materially reduced when one or more machines are idle.

As explained in the September issue of "Grits and Grinds," the total production from a wheel is materially greater when the peripheral speed is kept constant than if the wheel is kept running at the same number of revolutions per minute throughout its life. Variable speed motors furnish the ideal method of driving grinding machines and the next best system for maintaining uniformity of peripheral speed is to transfer the wheel when worn down to a certain number of inches on the diameter to a smaller machine, the spindle speed of which is such as to give the proper peripheral speed for the diameter of the wheel.

It is not infrequent, when following up a complaint that a grinding wheel has fallen off in quality, to find that the trouble is due to belt slippage. If belts are not kept in proper tension the friction of the grinding operation is sufficient to cause slippage, thus materially reducing the wheel speed.

Wheels 18" to 24" diameter are used on floor stands and swing frame machines, while 8" is as large as it is practicable to use on flexible shaft machines.

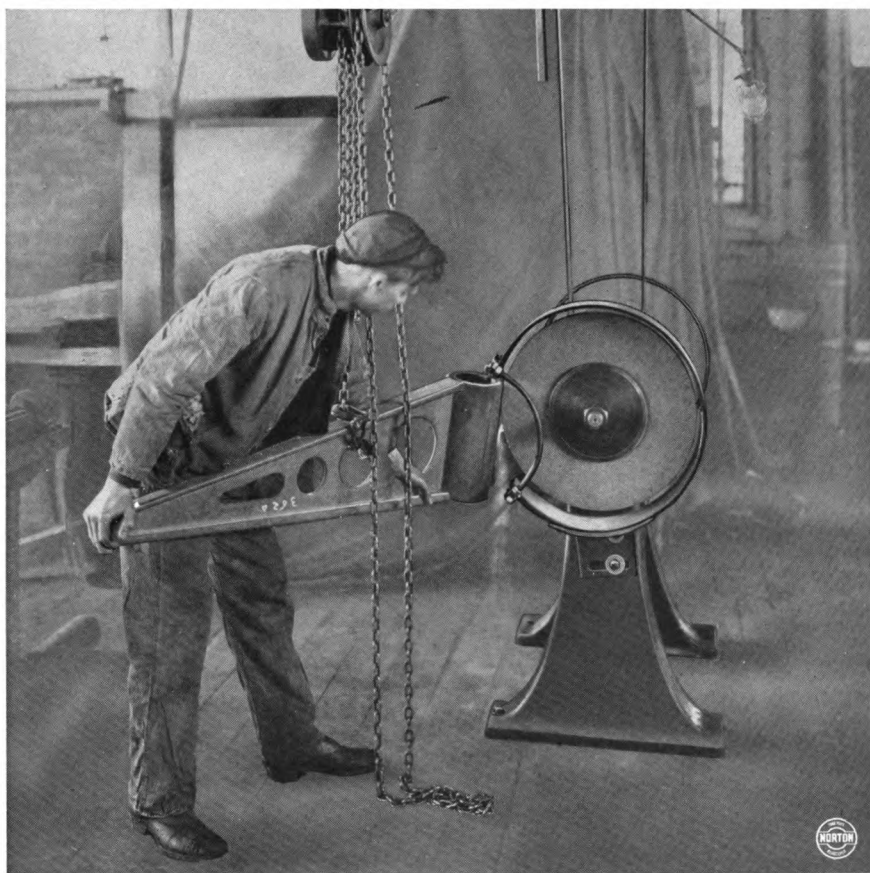
The size of wheels used on the lathe, boring mill and shaper depends almost entirely upon the kind and shape of work ground.

Wheels for grinding castings are operated at a speed of from 5,000 to 6,000 surface feet depending on the condition of the machine, the mounting of the wheel, degree of safety to the operator by the extent of safety equipment. For best operating conditions, this speed should be maintained throughout the life of the wheel.

The mounting of grinding wheels is an important item from the point of view of safety to the operator, and best practice demands that one man only have charge of the mounting of wheels.

Hoods Well-designed, substantial protection hoods offer the greatest known degree of protection from fragments of broken wheels. For efficient protection, small wheels should not be used with large hoods. Under conditions where it is not

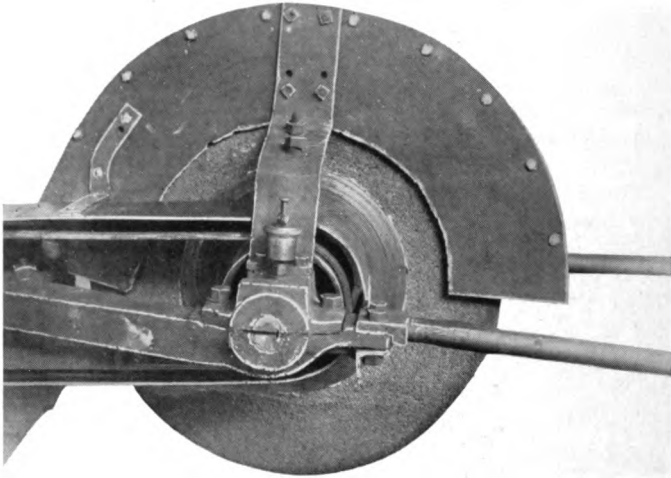
Because it is possible for a piece of the grinding wheel outside of the bevelled flange to cause damage in case of accident, the bevelled flanges do not offer as ample protection as protection hoods. Flanges of this type, however, when properly de-



Snagging with the Aid of a Chain Hoist

Protection Flanges practical to use a hood, bevelled wheels should be used and mounted between protection flanges of a corresponding bevel. The less the amount of wheel projecting beyond the flanges, the better protection offered to the operator in case the wheel should break.

signed, when relieved and properly adjusted do give protection in a high degree, particularly in instances where a wheel that may have been damaged by a fall or heavy blow has been mounted; but in no instance where the wheel is not surrounded by a hood should more than



Hood for Swing Frame Machine
Courtesy of National Malleable Castings Co.

2" or 3" of the wheel project beyond the flanges.

Dust System Wherever possible, the grinding wheel should be surrounded by a dust hood which in turn should be connected with an exhaust system. The elimination of dust not only prevents the contraction of lung diseases by the operators but saves wear and tear on the machinery and belts.

Spindles The grinding machine should be of rigid construction, with large spindles, well-fitted bearings and securely fastened on firm foundations. The following sizes of spindles are recommended except where the grinding wheels are extra thick.

Wheel	Spindle
6" diameter and less	$\frac{1}{2}$ "
8" " "	$\frac{5}{8}$ "
10" " "	$\frac{3}{4}$ "
12" " "	1 "
14" " "	$1\frac{1}{4}$ "
16" diameter and less	$1\frac{1}{2}$ "
18" to 20" diameter	$1\frac{3}{4}$ "
22" to 24" "	2"
Larger than 24" diameter	$2\frac{1}{4}$ " to 3"

Flanges should be relieved and at least one-half the diameter of the wheel with true bearing at the outer edge. Inner flange always fixed on spindle, never loose. Never use flanges less than one-third the diameter of the wheel.

Wheels must not be allowed to run when held only by a small nut instead of a flange as the nut is liable to crawl and cause accident.

Compressible washers of pulp or rubber, slightly larger than flanges, should be used between the wheel and flanges. They distribute the pressure evenly when the flanges are tightened by taking up any imperfections in the wheel or flanges.

The hole in the wheel should be bushed .005" large over standard size spindles. This permits the wheels to slide on the spindle without cramping and insures a good fit not only on the spindle, but against the inside flange, which is essential.

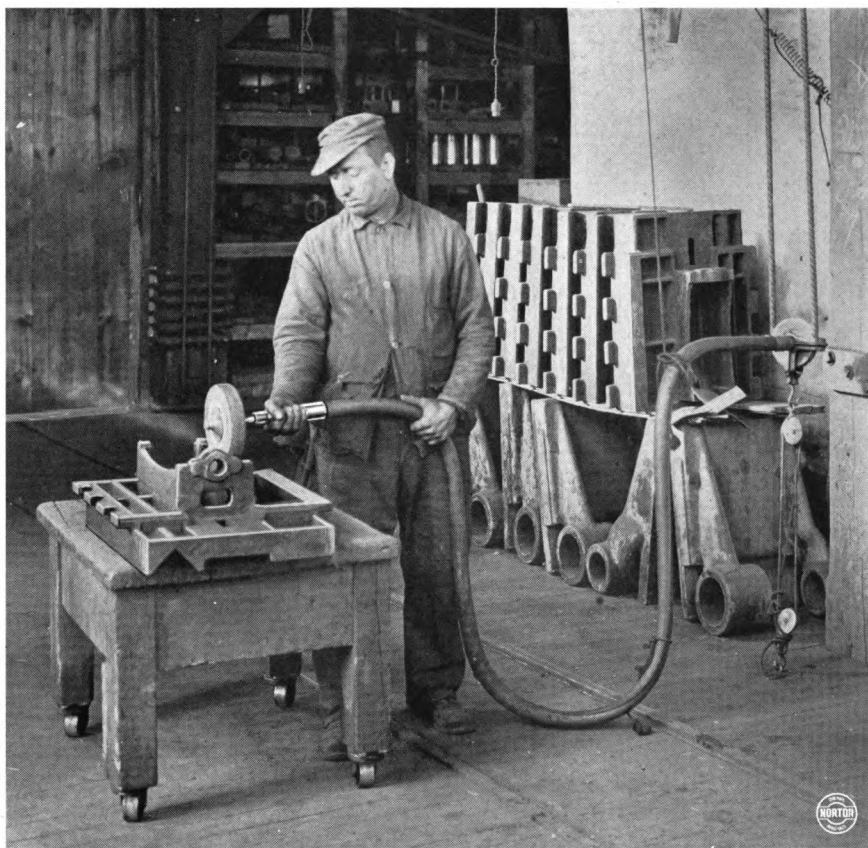
Tighten flanges only enough to hold wheels firmly, avoiding any unnecessary strain. The importance of this statement is emphasized by the fact that on a $1\frac{1}{2}$ " grinding wheel stand, equipped with 8" standard relieved flanges, a man with a

two-foot wrench can easily exert a crushing pressure between the wheel and flanges of 3,600 lbs. or over one and one-half tons.

Methods of Mounting—The illustration on page 6 shows the right and wrong methods of mounting wheels. Note that the wheel on the left has

instead of the pressure being distributed evenly over the whole bearing surface of the flange it is concentrated near the hole, creating a dangerous condition.

The inner flange should never be left loose on the spindle as in this case, but should be keyed or shrunk on. The rest



Snagging with Rope-driven Flexible Shaft

relieved flanges with compressible washers between wheel and flange, and a perfect bearing on the outer edge. Note beside it an improper mounting—straight flanges with no washers.

Tightening of the nut causes straight flanges to become slightly convex and

should be adjusted as closely as possible to the wheel to prevent work from being caught between the wheel and rest.

It is very seldom necessary to use a dresser when grinding very rough castings. Where men are not allowed to use dressers, it is noticed that the life of the wheel is

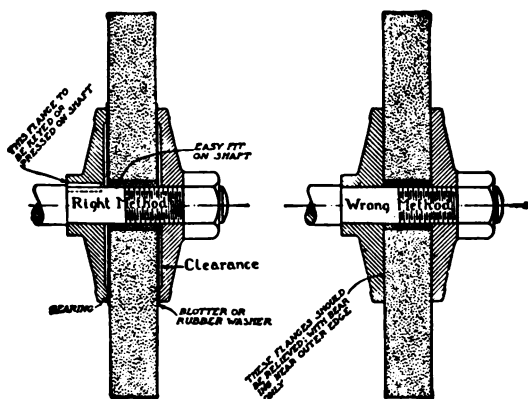


materially increased. A majority of grinding wheel operators tend to use a dresser more frequently than is necessary.

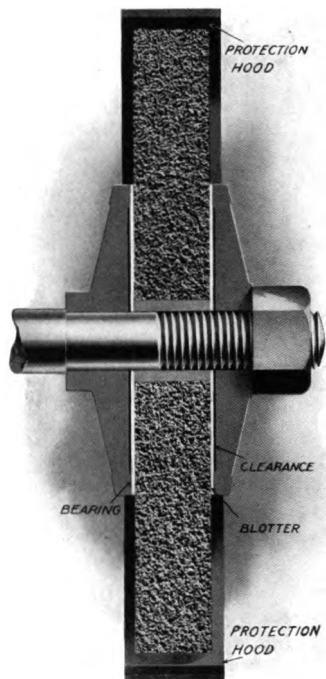
On account of the great variety of sizes and shapes of castings, the variety of methods in force, the variety of condi-

results, consideration must be given to the many details since slight changes of details necessitate perhaps a change in grain and grade to obtain best results.

Even a slight difference in conditions may affect the working of a wheel and for



While these sections illustrate the right and wrong methods of mounting regular-shaped grinding wheels, the same principles apply in the mounting of bevelled wheels with protection flanges of correct size.



Relieved flanges at least one-half the diameter of wheel—compressible washers between wheel and flange—perfect bearing on outer edge of flange—inner flange keyed or shrunk on spindle—wheel surrounded by protection hood

tions under which grinding wheels are used in the foundry, there is of necessity a great variety of wheels in use of different grains and grades and made of different abrasives. Practical experiments by those who are working for minimum grinding costs have brought them to the realization that to select grinding wheels that will give most efficient and most economical

this reason definite specifications of grain and grade cannot be recommended by the manufacturer as the best for any particular operation, unless all of the conditions are known.

The list of grains and grades following have been found to give satisfaction in a high degree on the operations named:

Selection
of Wheel



GRITS and GRINDS



Grain		Grade	
Large steel castings	10 to 14	Alundum vitrified	S and harder
Small steel castings	20 to 30	“ “	P to S
Large malleable iron castings	14 to 20	“ “	Q to U
Small malleable iron castings	20 to 30	“ “	P to S
Large cast iron castings	16 to 24	Crystolon vitrified	Q to U
Small cast iron castings	24 to 36	“ “	P to S
For machining alloy steel castings on lathe, boring mill and shaper types of machines		Alundum vitrified	N to Q
Brass and bronze castings	24 to 36	Crystolon vitrified	O to Q
Aluminum castings	30 to 36	Crystolon elastic	4 to 5

It will be noted that in the above list cast iron, brass, bronze and aluminum are ground with Crystolon wheels, while the steel castings and malleable iron castings are ground with Alundum wheels. However, unannealed malleable iron castings are an exception to the above rule, and Crystolon wheels are usually found more satisfactory on this work. Elastic wheels are recommended for grinding aluminum because a wheel made of this bond has less tendency to fill with the metal being ground than a vitrified or silicate wheel.

The two main factors that are influential in determining the selection of grain and grade for any operation are rigidity of machine and speed of wheel. The more rigid a machine is, the softer the grade of wheel that may be used. Likewise, the more rigid the piece to be ground is held, the softer the grade of wheel. Very rough castings that are covered with fins, burrs and sprues require a very hard wheel, since the casting has more or less of a dressing action on the wheel. However, where it is necessary to grind the castings to a gauge limit and surface grinding must be resorted to after the fins have been removed, a softer wheel than that used for rough work will give better results because the grade of wheel used for rough work is too hard for surface grinding.

In cases where it is impossible to operate the wheel at the recommended speed and a very much slower speed must of necessity be used, the grade of wheel should be harder than if the machine were run at the right speed.

The factors which influence the size of grain in a wheel are largely dependent upon the kind of surface desired in the finished piece. If the kind of surface is not important, it is a matter of economy to use a coarse grain wheel for fast cutting; if the work is to receive a coating of enamel after it is ground—such as cast iron bath tubs, a fine surface is essential which is obtained by the use of wheels, No. 30 or 36 grain.

The question which naturally comes up in the minds of all foundry-men interested in the grinding department is—can the cost be lowered in the grinding department without decreasing the production rate? Attention is immediately directed to the grinding wheel and it is wondered if the wheels being used are the best obtainable for the uses to which they are put. Both experience and trial largely control the proper selection, while for efficiency the principles as discussed in last month's issue of "Grits and Grinds" apply.

It may again be emphasized, however, that if accurate conclusions are to be reached, the hourly production or earning power of the wheel, the total time it lasts and its cost must be taken into consideration. All grinding wheel manufacturers stand ready to serve users of grinding wheels to the best of their ability. The grinding problems, with which the wheel makers come in continual contact, give them experiences which are found valuable, to those who take advantage of this source of knowledge.



Bushing Grinding Wheels

While it is of the utmost importance that grinding wheels should be properly bushed, very crude and inefficient methods are in use in many places and it is not surprising that grinding wheel troubles result.

Chuck The suggestions given here are based on the bushing methods in vogue at the Norton plant where bushing chucks of the type shown here are used. The first requisite for bushing wheels is a chuck of this or similar type in order that the hole may be centered. These chucks are manufactured by Norton Company and sold by Norton agencies.

Lead Lead can be judged by the color. Soft pig lead has a greenish purple tinge when hot. This is too soft for the bushing to retain its shape and it will not stand careless handling when placing on a machine spindle.

Frequently, the complaint that a wheel is "out of truth" is caused by the bushing being too soft. The lead when hot enough to bush with should be of a grayish color.

Babbitt Babbitt is a much harder material and, therefore, better adapted for bushing cup wheels with large overhang. Very coarse wheels that are subjected to hard pressure on the periphery stand up much better if bushed with babbitt.

Position One should be careful to see that the wheel lies flat on the bushing chuck; then move lever on chuck until the wheel is gripped tight, being careful to see that you do not raise the wheel from the chuck, otherwise you will have a lot of lead on the under side of the wheel.

It is advisable to remove the blotters from sides of wheel before bushing.

If you do not care to do that make a paper collar the same thickness as the blotters and small enough to go inside of hole in blotters and fit on the arbor. This will keep the new lead bushing even with the old one and will save trouble with wheel running out on the sides. It is also advisable to put two or three

notches in the old bushing, with a hammer and chisel, to make the new lead unite more securely with the old.

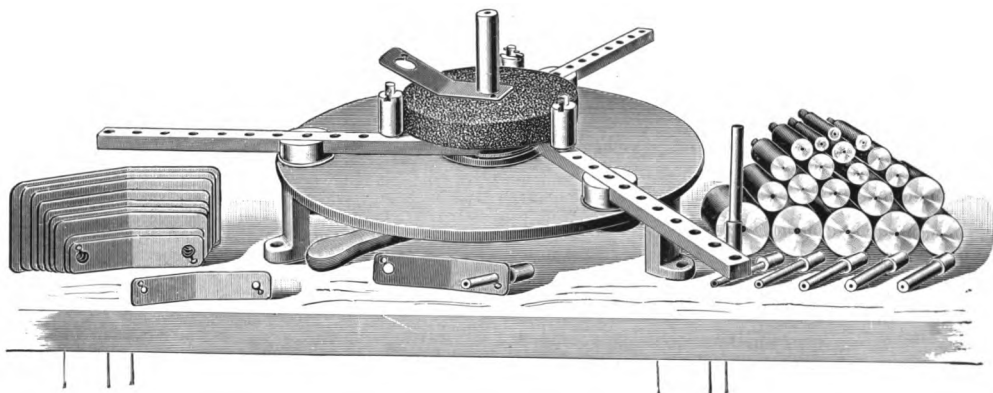
First get the arbor of the size you desire **Operation** to use and see that it fits in taper hole of chuck. After you are satisfied it fits, take out arbor, place wheel flat on chuck and move lever until tight. Then put in the arbor, slip the bushing cleaner over the arbor, holding it down firmly on the wheel. Fill the ladle with lead and pour it through cleaner hole into the wheel. Let it cool half a minute, turn the cleaner so as to cut off pouring tap, take off the cleaner, remove wheel from chuck and rest it on the floor or bench while you drive out the arbor.

It is important that the lead bushing does not protrude outside of the wheel. It is, therefore, necessary to trim off the bushing with a chisel even after a cleaner has been used as the lead will sometimes be above the side of the wheel.

When wheels are not properly bushed, they will run out of truth on the sides, which indicates that the hole is not at right angle with sides of the wheel. In mounting the wheel, a careless operator might not notice such a condition and tighten the wheel up against the stationary flange on his grinding machine spindle. Usually this breaks the wheel, but if it does not, the wheel is very liable to break when it comes in contact with the work. **How to Avoid Trouble**

It is more dangerous when the wheel does not break when mounting as placing it in contact with grinding work places extra strain on it, and the wheel breaks when revolving.

Another cause for breakage at times is bushing left sticking out on the sides of grinding wheels. If they are mounted with lead bushings protruding, pressure on the lead, when the wheel is tightened in place, is sufficient to break wheels, or put such additional strain on them that they will break later while in use.



Bushing Chuck and Arbors

Sometimes, when wheels are piled one on top of another, a protruding lead bushing in the pile will cause such a

strain from weight of wheels on top, that a soft or thin wheel will break under it.

Importance of the Mechanical Properties of a Metal in Solving the Grinding Problem

Grinding problems often fail of solution because of ignorance of the mechanical properties of the material being ground.

A situation is recalled from our last salesmen's conference where A said that at Smith & Co.'s such and such a wheel was the best ever used for grinding cast iron. Salesman B immediately quoted the use of the same wheel under the same conditions on cast iron at Jones & Co.'s where it was a failure. Either the grinding conditions were not the same in both cases or the conditions were the same and the discrepancy was due to a difference in the properties of the cast irons being ground.

This article discusses the properties of cast iron in an endeavor to show their *importance* in solving grinding problems. It should be borne in mind that there are other factors which are just as important

—wheel speed, conditions of the machine, contact, etc. However, for a given case let us assume these other factors constant.

The influence of the properties of cast iron on its grinding quality is probably more marked than that of other materials. Two cast irons having the same chemical composition may show entirely different mechanical properties caused by different rates of cooling, which in turn may be caused by the size of the castings or whether cast in an iron or sand mould. A case is noted in a paper presented before the American Society for Testing Materials where a difference of $\frac{1}{4}$ of an inch in the dimensions of test bars, identical in chemical composition and poured from the same ladle showed variations in tensile strength of between 2,250 lbs. and 7,500 lbs. per sq. in. Cast irons which are cooled rapidly, such as iron mould

castings, are very hard and brittle, due to a brittle compound which they contain. Cast irons slowly cooled, such as sand mould castings, are soft and weak; soft because the brittle compound has had time to break down into two soft components, graphite and free iron. Graphite has the property of making cast iron as a whole very weak. A grinding wheel which was successful on the hard, brittle material would certainly not be successful on the soft, weak material. Yet they are both cast irons.

It is possible for a large casting to be hard and brittle on the surface and soft and weak on the inside. A wheel efficient

on the outside of such a casting would not be efficient after the casting was turned down to the soft interior. By a microscopic examination such a difference in the properties of two materials would be quickly determined.

Practical application in foundries and steel mills of microscopic examinations confirms the existence of a definite correlation between the micro-structure and mechanical properties of metals. Therefore the grinding quality of a metal as measured by its mechanical properties can be determined from its micro-structure.

Difference Between Glazing and Loading

The difference between glazing and loading of a grinding wheel is not always clearly understood. This difference may be seen in the accompanying illustration by close examination of the different wheel faces shown.

The picture on the left shows a wheel face in good condition for work. On the right we have a glazed wheel and in the centre a loaded wheel.

Loaded Wheel A loaded wheel is one whose face has particles of the metal being ground adhering to it—one in which the openings or pores of the wheel face have been filled up with metal, leaving no room for clearance. It is not necessary that all of the pores or openings between the cutting particles on the face of a wheel be filled up or loaded to prevent the wheel from cutting. The presence of a number of these pieces of metal on the face of a wheel prevents the wheel from cutting into the work, and the loaded places will of course create heat.

Glazed Wheel A glazed wheel is one whose cutting particles have become dull or worn down even with the bond, the bond being so hard that it does not wear away fast

enough to allow spaces between the cutting particles, or the cutting particles to escape when dulled. In a glazed wheel, the cutting particles and the bond at the extreme surface of the wheel are of the same radius.

Examination of the picture will show that the wheel on the left appears much sharper and has many more open spaces between the cutting particles than the one on the right. While the picture on the right shows open spaces between the cutting particles, there are not as many and the face of the wheel is not sharp when compared with the one on the left. It will be noted that in many places the space between the cutting particles is filled with bond and the corresponding spaces in the wheel on the left are open and will give room for clearance. Continued work with a wheel that glazes increases the smoothness of the wheel face and decreases the cutting.

A wheel will not load unless the bond is too hard or it is run at a speed very **Causes** much too slow. The factors that cause loading are, therefore, hard bond and slow speed. Loading may indicate that

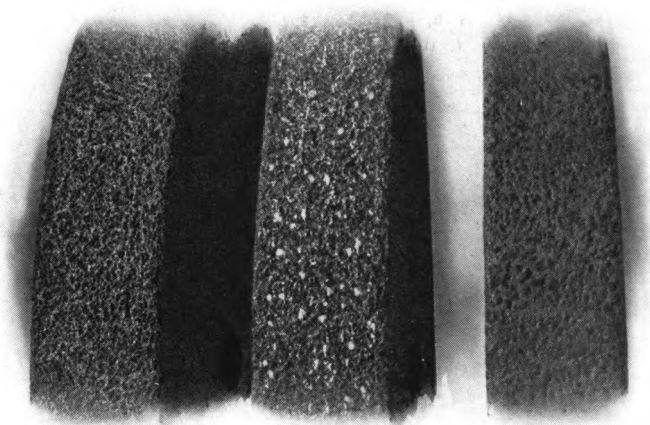


the wheel is too hard or that it is running too slow, or both.

The factors that cause glazing are hard bond and high speed. Glazing may indicate that the wheel is too hard for the work, or it may be running too fast. A wheel of the right grain and grade may glaze if run too fast, or a wheel run at the right speed may glaze if it is too hard for the work. In short,

wheel that ran out 1-32 of an inch after one hour's grinding ran out 1-8 of an inch after two hours' grinding. Had it been dressed after the first hour and again after the second hour, the amount wasted by dressing would have been 1-16 of an inch, whereas after the wheel ran two hours it was necessary to dress off 1-8 of an inch or twice as much.

Wheels should be kept in perfect run-



Appearance of Wheel Faces when Sharp, Loaded and Glazed

a wheel loads when it is too hard or when it runs too slow, and a wheel glazes when it is too hard or runs too fast.

One remedy for loading is to increase the speed. A remedy for glazing is to decrease the speed. If the speeds are right, use a softer wheel in either case.

Loading and glazing make excessive dressing necessary, and excessive dressing wears wheels faster than grinding. Were it possible to obtain an ideal wheel for each kind of work, theoretically dressing would not be necessary as the face of the wheel would automatically sharpen itself.

Whenever the work is of such a nature as to cause the wheel to run out of true, frequent dressing will save the wheel rather than waste it. For example, a

ning condition, in order to give good results and a wheel should never be used until the operator is sure the wheel runs true.

We can never grind perfect work with an imperfect wheel, and the more perfect and smooth the wheel is the more perfect and smooth will the work be, particularly when making the light finishing cuts.

Dressers should always be kept handy for wheels for off-hand grinding, but for truing wheels on plain, cylindrical and universal grinding machines, cutter and reamer grinders, etc., a diamond is necessary for good results.

Dressing is not truing, but sharpening the wheel, and a dresser should never be used on wheels that grind round



work on centres. When truing a wheel for round grinding, the diamond should be held in a rigid tool post on the table of the machine. You cannot do good work with a wheel that has been trued "by hand." When a dresser is used, it should be moved in a straight line across the face of the wheel, with the heel of

the dresser resting firmly against the edge of the work rest.

It may be well to state here that dressing is sharpening the wheel, and truing means to perfect the wheel—make a perfect cylinder of it, which is absolutely necessary if it is intended to grind a perfect cylinder with it.

Some Pertinent Suggestions

For Ordering

Orders are frequently received by grinding wheel manufacturers that lack the details necessary for prompt and intelligent execution.

Do not fail to give the diameter of wheel, thickness, and size of hole, and if special faces, state the kind of face. If you have been using one that is perfectly satisfactory, specify grain and grade, also the order number of the last wheel used.

When the exact grain and grade required for the work are not known, give the following conditions as far as possible:

Kind of material: whether iron—cast, wrought, or malleable—brass, composition, hard steel or soft steel.

Description of article—state if grinding is off-hand or automatic; whether the wheel contact will be broad or narrow.

Speed of wheel spindle; and if it is cylindrical grinding, speed of work.

Slight differences in speed cause big differences in the working of wheels. A change of speed may cause its success or failure.

State whether wet or dry grinding.

The tag which comes with the wheel should be preserved and referred to when re-ordering. This tag gives the grain and grade of the wheel and both the customer's and our order numbers.

Special information blanks are furnished by us to anyone sufficiently interested to send for them.

Truing and Dressing

Whenever the work is of such a nature as to cause the grinding wheel to run out of true, frequent dressing will save the wheel rather than waste it.

A grinding wheel should never be put to work until the operator is sure it runs true.

The best grinding results can be obtained only when the wheel is kept in perfect running condition.

Dressing is not truing but sharpening the wheel, and a dresser should never be used on wheels that grind round work on centers.

A wheel is made perfect by "truing" and it is made sharp by "dressing."

When a dresser is used it should be moved in a straight line across the face of the wheel, with the heel of the dresser resting firmly against the edge of the work rest.

A large supply of water should always be used when truing with the diamond.

The large corrugated and twisted cutter dressers are recommended for the larger and coarser wheels. The small twisted cutter dresser, or the Huntington, for smaller and finer wheels. The small twisted cutter dresser is about one-half the size of the large ones.

Excessive dressing wears wheels faster than grinding. If too much dressing is necessary, it is an indication that the wheel is too hard for the work.



CHAS. WOOD

GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

NOVEMBER

1913



GRINDING A MANGANESE STEEL PINION
Courtesy Edgar Allen American Manganese Steel Co.



Grits and Grinds

Vol. V

November, 1913

No. 7

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Dynamic Balance

Discussion of Standing and Dynamic or Running Balance—The Inefficiency of Standing Balance and the Importance of Running Balance—Description of Norton Running Balance Indicating Machine

Nearly everyone understands the standing balance, but very few understand running balance, nor do they realize the importance of "putting in running balance" a high speed revolving machine part.

Lack of running balance produces not only a vibration of the unbalanced part but of the whole machine. For instance, if the wheel spindle of a cylindrical grinding machine should be out of running balance, the vibrations will result in chatters on the work. If the flywheel or crank of an auto engine is badly "out," the whole car will shake. Not only are the vibrations unpleasant to feel, but they are very destructive to the engine, the frame, bearings and joints. Another instance illustrating the importance of running balance (taken from the American Machinist) is given briefly as follows: "It has been found that small drills cut better at very high speeds, but the drilling machines would not stand such speeds. They soon went to pieces because their parts were out of running balance."

On page 241 of the American Machinist for August 11, 1910, will be found the following seven statements in regard to running balance:

All rotating parts of high speed machinery should be running balanced.

A part in running balance will also be in standing balance.

A part in perfect standing balance may be very far from being in running balance.

The operation of standing balancing may be a detriment instead of a benefit to high-speed machine parts.

A part in running balance at one speed will be in running balance at all other speeds, providing it does not distort from centrifugal action.

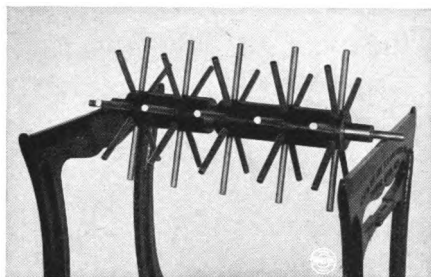
Exact symmetry of form is no guarantee of running balance.

High-speed parts should be so designed that they will not distort from centrifugal action if rotated free at any speed at which they may run in use, and thus destroy a state of running balance.

The test arbor, shown in Fig. 1. is constructed so that each and every spoke in a set is diametrically opposite another of the same length and weight. The arbor or "porcupine," as it is called, is therefore in standing balance, provided the metal is of the same density throughout. Fig. 1 shows the "porcupine" in standing balance on the horizontal ways.

Equal balancing weights are provided

We have seen that the test arbor, as shown in Fig. 2 is in standing balance. Now let us see why this arrangement of the weights does not give a running balance. Just as soon as the "porcupine" starts to revolve in bearings, each weight begins to exert an outward pull or centrifugal force at its end of the arbor. This pull is like the pull of a stone when whirled around in the air on the end of a string. The higher the speed of revolution, the greater the pull. The centrifugal force of one weight is equal but opposite to the centrifugal force of the other weight and both forces are continually changing in direction as the piece revolves. Moreover, the forces act in two different planes of revolution. The effect of two such forces on a rotating body, supported by bearings which are free to swing, is



It is readily seen that a second weight at the end of the opposite spoke in set No. 1 will put the arbor "back in balance." However, this is not the only position to produce a standing balance, for the tendency of a weight to make the arbor roll on the ways depends only upon the amount of the weight and its distance from the axis of revolution, and not upon the position of the weight along the length of the arbor. Consequently, the second weight may be placed at the end of the opposite spoke *in any set*. Fig. 2 shows the "porcupine" in standing balance with the second weight (B) in set No. 5.

Therefore, to put an unbalanced body in standing balance, simply place the correct balancing weight *anywhere* along the length of the body on the light side; or if stock is removed, drill out the required amount of metal *anywhere* along the length of the body on the heavy side.

The method just described is exactly the way in which every machine shop obtains a standing balance. Of course, the standing balance is made so that the part will run smoothly and without vibration when assembled in the machine. But, is the condition of smooth running

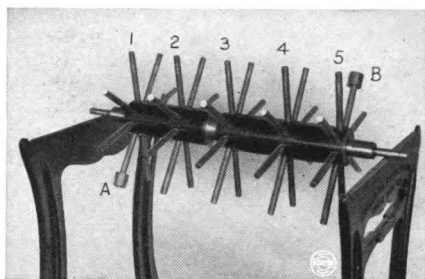


Fig. 2

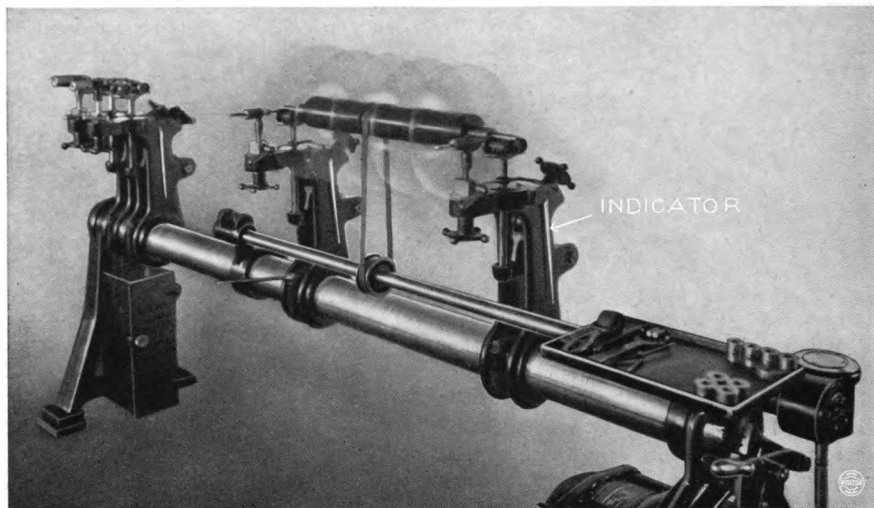
to make the body wobble. This wobble is clearly shown by the blur of the indicators in Fig. 4, where the test-arbor is shown revolving in the Norton Running Balance Indicating Machine. Compare Fig. 4 with Fig. 3 where the arbor is shown revolving without any vibration. Figs. 1 and 3 show the test-arbor in standing and running balance. Figs. 2 and 4 show it in standing balance, but *not in running balance*.



Referring to Fig. 2, it will be clear, that in order to get rid of this wobble and thus put the arbor in running balance, the balancing weight (B) must be placed at the end of the opposite spoke in set No. 1, that is, in the same plane of revolution with weight (A). There the equal and opposite pulls of the weight act in

6) there will be just one light spot to locate. If both ends "are out," the indicators tell us whether each end "is out" about the same or whether one end is worse than the other.

Horizontal ways fail to give a body a running balance because they do not balance with reference to the length of



Dynamic Balance Fig. 3

the same plane and opposite each other, and so cannot cause the arbor to shake.

From the foregoing, it is seen that putting a body in running balance is different from giving the body a standing balance, *in that one must balance with reference to the length of the body*; or, since any piece can be running balanced by putting a sufficient amount of weight at a certain spot in each of the two end planes of the body, one must know the location of these two light spots. Now, the Norton Running Balance Indicating Machine always and surely locates each light spot at the ends or sides of the body. It is then an easy matter to put on enough weight at each spot (or drill out enough weight opposite the light spots) to cause the body to run without any vibration. Of course, if only one end of a piece is out of running balance (like the crank in Fig.

the body. The following table gives actual conditions, found when putting in running balance parts which had been sent to the Norton Grinding Company by various well-known firms. It will be noticed that the errors partly or entirely cancel each other, so that the parts were out of standing balance only a small amount as compared with the amount of error in running balance.

The first column gives the number of ounces which added (usually to the largest diameter) would put the piece in standing balance,

The second column gives the number of ounces that were added (or removed) at or near the ends of the piece to put it in running balance.

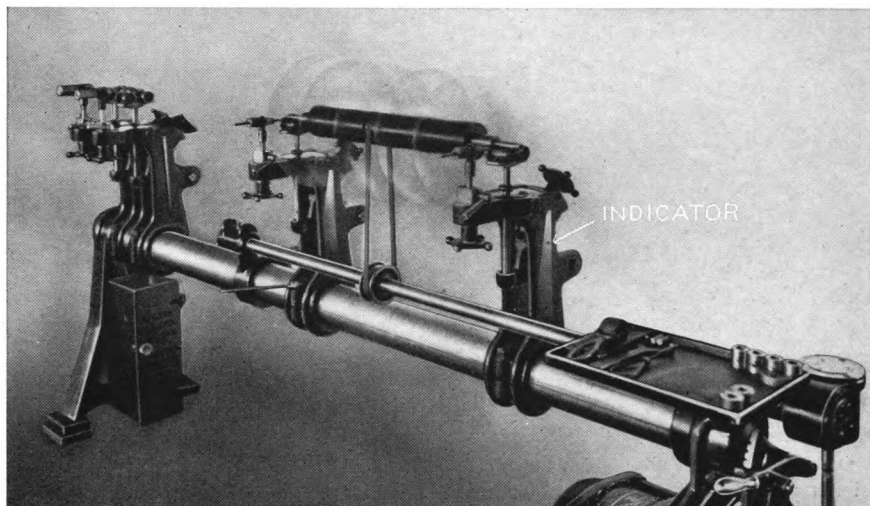
Name of Part	Ounces out of Standing Balance	Ounces required to put in Running Balance
Flywheel	2¼	3½
Crank	1¼	4½



Clutch	$\frac{3}{8}$	$2\frac{3}{4}$
Crank	$\frac{3}{4}$	$8\frac{1}{4}$
Flywheel	$\frac{3}{4}$	$5\frac{1}{2}$
Crank	3	10
Armature	0	$2\frac{1}{2}$
Armature	2	6
Flywheel	$1\frac{3}{4}$	$4\frac{1}{2}$
Crank	4	7

adapted for automobile crankshafts, flywheels, and clutches; spindles, pulleys, and belt drums of machine tools; cutter cylinders for woodworking machinery; for armatures of motors and generators, etc.

The part to be balanced is revolved on friction-reducing bearings which are mounted on inverted pendulums. These



Dynamic Balance Fig. 4

Two instances of the error being "all on one side" are given as follows. A flywheel which had been put in standing balance by the maker was found to be $27\frac{1}{2}$ ounces out of running balance. The balancing had been done on the wrong side, thus doubling the error. Two drums were sent to the Norton Grinding Company to be running balanced. They had been standing balanced with the idea of making the running balance job cheaper. As a matter of fact, the drums were about $19\frac{1}{2}$ ounces out of running balance. The owners had taken the wrong end, as usual, and their work had to be done over again. These examples are proof of the inefficiency of the standing balance.

The Norton Running Balance Indicating Machine is made for locating errors in running balance of revolving parts of machines. The cuts show the machine as

pendulums are free to swing (limited by a rubber bumper) back and forth in vertical planes. The body then has a limited amount of motion in a horizontal plane. All vibrating parts are strong, though light. As a result of these conditions, the machine is extremely sensitive.

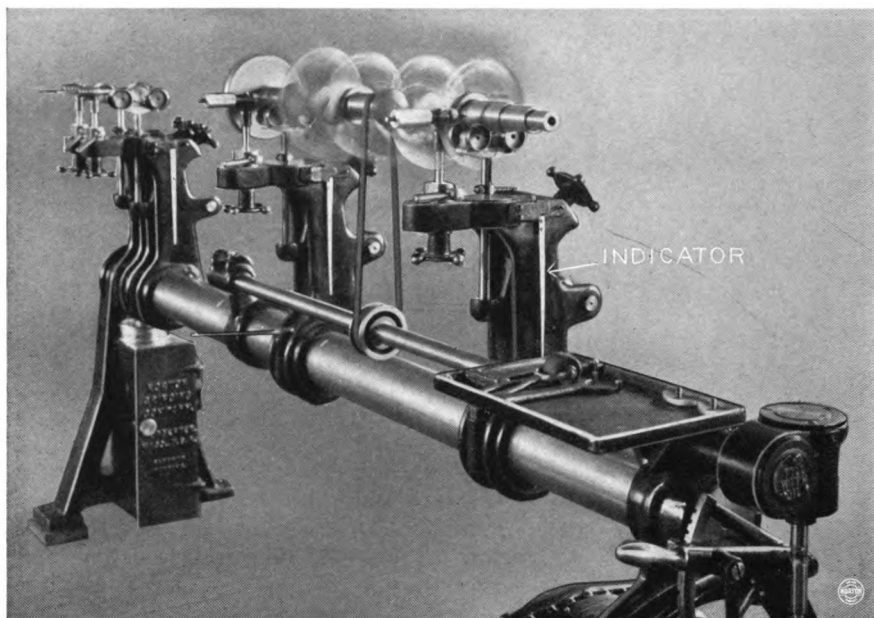
The machine is perfectly universal. The uprights, containing the bearings, brass scriber, indicator, and belt tightener can be moved to any position along the bar. The standard machines are built in two sizes, one having a maximum distance of 44" between bearings, the other size taking 66" between bearings. If a capacity of more than 66" is required, machines will be built to order. The maximum swing of the machines is 24" in diameter. The weight of the machine, ready for shipment, is about 650 pounds.

The standard machine is fitted with a constant speed 1 H. P. motor; this motor



may be either alternating current or direct current, to suit the customer's conditions. For extra heavy work, the machine can be fitted to order with either a 2 or 3 H. P. motor. Variation in speed of work revolution is obtained by mechanical means through a friction disc attached to the motor shaft. This friction drive also permits rotation in two directions, which

does not have to make a truck-horse of himself lugging, say, flywheels and cranks across the shop. Remember that the marking is done very quickly, and that nearly all the time is used up by removing or putting on the metal. The time for balancing a piece therefore, depends upon handy tools and quick methods of drilling, snagging, or fastening on weights.



Dynamic Balance Fig. 5

is absolutely necessary. Further variations of work speed are obtained by split pulleys of various sizes which are interchangeable on the driving shaft.

The machine is equipped with three sets of interchangeable friction-reducing bearings; two split driving pulleys, of different sizes; brass scribes; wrenches; color roller and color tray.

For efficient commercial balancing, tools to remove or put on metal should be handy to the Balance Indicating Machine. If stock is to be drilled out or snagged off, place a drilling machine or a "snagging" machine near enough so that the operator

When balancing auto-crankshafts, metal may be removed in most cases by rounding off the corners of the "cheeks." The quickest way to do this is by "snagging" with a heavy grinding wheel. Sometimes it is necessary to remove stock from the "flats." If there is much to come off or if a lot of cranks all seem to run heavy across the "flats" on one side, it will be quicker to plane or mill off the stock. Make the distance from the "flats" to the bearings or pins the same on each side. It will then be easy to do the rest of the balancing by working with the corners.

(TO BE CONTINUED)

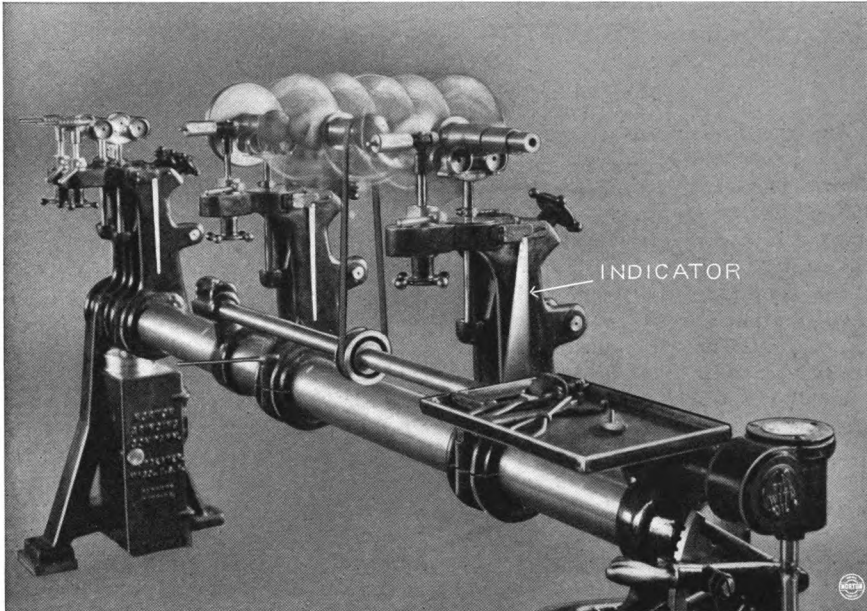


Norton Exhibit at Chicago

In connection with the 1913 convention of the American Foundrymen's Association held in Chicago on Oct. 10th to 17th, the Norton Company had a working exhibit. For the first time, two of the new line of Norton Grinding Wheel Stands

occur in grinding practice. This machine afforded opportunity for a striking demonstration.

Norton Crystolon Wheels mounted upon a Coates Flexible Shaft grinding outfit formed another interesting feature



Dynamic Balance Fig. 6

were shown—a 2" floor type and a $\frac{3}{4}$ " bench type. Upon these machines was also shown, for the first time, the new type of Norton hood. These new machines, which were a centre of interest and attracted favorable comment from visiting foundrymen, will be described in an early issue of "Grits and Grinds."

Another machine which gave ample opportunity to show the cutting action of Norton wheels was a swing frame grinding machine of the Ransom type, equipped with a 24" Alundum wheel and operating upon manganese switches and cross-overs, one of the most difficult operations that

especially when used for grinding cast iron sinks and tubs.

The work used to demonstrate the floor stand was varied in character; brass and bronze castings, iron castings, malleable castings, malleable pipe fittings, manganese steel fish plates, etc.

An electric furnace was used in connection with a working exhibit of Norton Alundum Refractories. Electric furnaces of the wire resistance type, similar to the one shown, can be used in many operations. In the demonstrations at the exhibit it was used in the heat treatment of such articles as small tools, gears and



pipe fittings. The temperature is uniform and always under the operator's control so that many types of operations can be carried on economically and with a greater assurance of uniformity.

A Hoskins furnace used in this exhibit was fitted with muffles made by the Norton Company, who also made the small

protection hoods for the thermocouples.

Various specimens of metals such as manganese steel, tungsten high speed, high carbon, low carbon and Novo steels, and wrought iron, were at hand for the purpose of demonstrating how the character of metals may be determined from the sparks made by grinding.

Economy in the Production of Ground Shafts

By J. C. SPENCE

An investigation was recently made into the most economical method of producing ground shafts $62\frac{1}{4}$ " long by 1.5605"-1.5615" diameter. The material was Open Hearth machinery steel, 0.35% carbon, $1\frac{1}{8}$ " in diameter.

It was determined to turn one half of the shafts to a size that would allow the grinding machine to "clean out" all of the turning tool marks without being too "fussy" about straightening the shaft, after the turning operation.

The other half of the lot was ground directly from the black stock, without any lathe operation.

The first half lot was turned .020" to .025" oversize at a cutting speed of 95 ft. per minute and a feed of 1-40 inch per revolution of the work.

The cutting time was $11\frac{1}{2}$ mins. per shaft. The total lathe time, including handling, was 14 mins.

The shafts were then ground to the given size in $21\frac{1}{2}$ mins.

This gave a total time of $35\frac{1}{2}$ mins.

The other half of the lot, ground from the black, required $30\frac{3}{4}$ mins. each, to grind them to the given diameter.

The time for straightening these shafts has been omitted because it is such a variable quantity. However, it is a much greater item after the turning operation than after the rough grinding operation (it being customary to rough grind a lot of shafts and then to finish grind).

This is due to the fact that, in the

turning operation, the lathe tool removes the stock in one cut thus releasing, at once, all of the strains set up in the outer shell, by the rolling operation, at the steel mill. This causes the bar to spring "out of true" to the greatest possible extent.

On the other hand, the wheel cuts only a thin outer shell, at each pass, and the amount of spring is correspondingly small. The next pass of the wheel cuts off the eccentricity caused by the previous pass but not necessarily adding to the eccentricity.

Given the proper wheel and skill, there is no need of springing work in the grinding machine.

Again, the fact that a turned piece "runs out," means that the grinding machine has just that much more work to do.

For instance, a piece of work that has, by measurement, .020" of stock to be removed from the diameter, will have the "equivalent of .030" stock provided it runs out .010" (indicated).

Thus we see that, even by omitting the straightening operation which would still further militate against the lathe, there is a gain of 13% in favor of the grinding machine.

The same general proposition holds true even when there is too much stock to allow the grinding machine to be economically used in the roughing operation.



In this case, it can be laid down as a rule that it pays to save time on the lathe and give the grinding machine more to do. This means get rid of the great bulk of the stock as rapidly and with as little attention to refinement as possible, even to the extent of sometimes taking two or three very coarse chips in preference to one fine one.

The proposition is true because while a coarse chip leaves a very rough surface that, apparently, has much stock to be removed, this surface consists principally of the points of small triangles and the

heavy modern wheel makes them disappear "like chaff before the wind."

This is the better realized when it is learned that a shaft 20" long turned at 15 threads to the inch by a "round nose" tool to a diameter of 2.425" at the tops of the tool marks, was reduced to 2.400" (the bottom of the tool marks) in one minute of cutting time. This is an apparent stock removal of 1.9 cubic inches per minute and enables one to understand why the old fashioned "finish-ing cut" is doomed.

Visit of A. S. M. E. to Worcester

The Boston section of the American Society of Mechanical Engineers visited Worcester, October 17. The local committee, of which Professor W. W. Bird of Worcester Polytechnic Institute was chairman, had laid out a full programme for the afternoon and evening.

The parties which had been visiting various plants in the city gathered together shortly after 4 o'clock at the administration building of the Norton Company and went at once to the assembly hall. In this hall, which will accommodate about 250 persons, three short talks were given. Aldus C. Higgins confined his talk, which was illustrated by lantern slides, to abrasives. Artificial abrasives, made by the aid of the electric furnace, are the only ones used by the Norton Company and Mr. Higgins traced their manufacture from raw material to the crushed lumps, in which condition the abrasives are sent to the grinding wheel plant. At this point, Carl F. Dietz told how modern grinding wheels are made, showing the important operations, and following a wheel from department to department by means of lantern slides. Mr. Dietz closed his talk with slides which showed the efficiency of the different abrasives on various materials and also how these efficiencies are determined.

Mr. Charles H. Norton was the next speaker. He made in a very convincing manner the point that all cylindrical

work will be made much cheaper, when managers, superintendents and foremen understand how to *combine* the lathe and the grinding machine in the way to get the best results. He showed that at present the lathe operator wants to turn out a good traditional "lathe job," even when grinding is to follow. The economical way is to *rough turn* rapidly with coarse feed and let the grinding machine do the rest. The combined time of turning and grinding will by this process be greatly reduced. Mr. Norton appealed to engineers to take up this question of the proper *combination of lathe and grinding machine* as it offers a most fruitful field for the *efficiency department* of shops producing cylindrical work.

Opportunity was then given for everyone to inspect the Norton administration building, which contains the Research Laboratories, or take a trip through the grinding wheel plant. After the trip through the wheel plant, practical demonstrations were given at the Norton Grinding Company. These consisted of cylindrical grinding of long shafts, both from the black stock and from rough turning in the lathe; grinding integral cams on automobile cam shafts; surface grinding on the new Norton Surface Grinding Machine and demonstrations of the Norton Running Balance Indicating Machine and cutter and tool grinding.



The New Store of The Cleveland Tool & Supply Co., Cleveland, Ohio

On this and the following page are views of the Norton section in the new store of The Cleveland Tool & Supply Co., a building four stories high and basement, containing 68,000 square feet of floor space. On the street floor is an attractive and well-lighted department devoted to grinding wheels and grinding machines, 75 x 20 feet, with wheel racks on both sides containing 949 running feet.

A well arranged display of Norton India and Crystolon Sharpening Stones in the display case of the Pike Manufacturing Co. adds much to the general attractiveness of the whole. A space approximately 55 feet long by 8 feet wide in the basement is devoted to the storage of wheels specially ordered by large consumers.

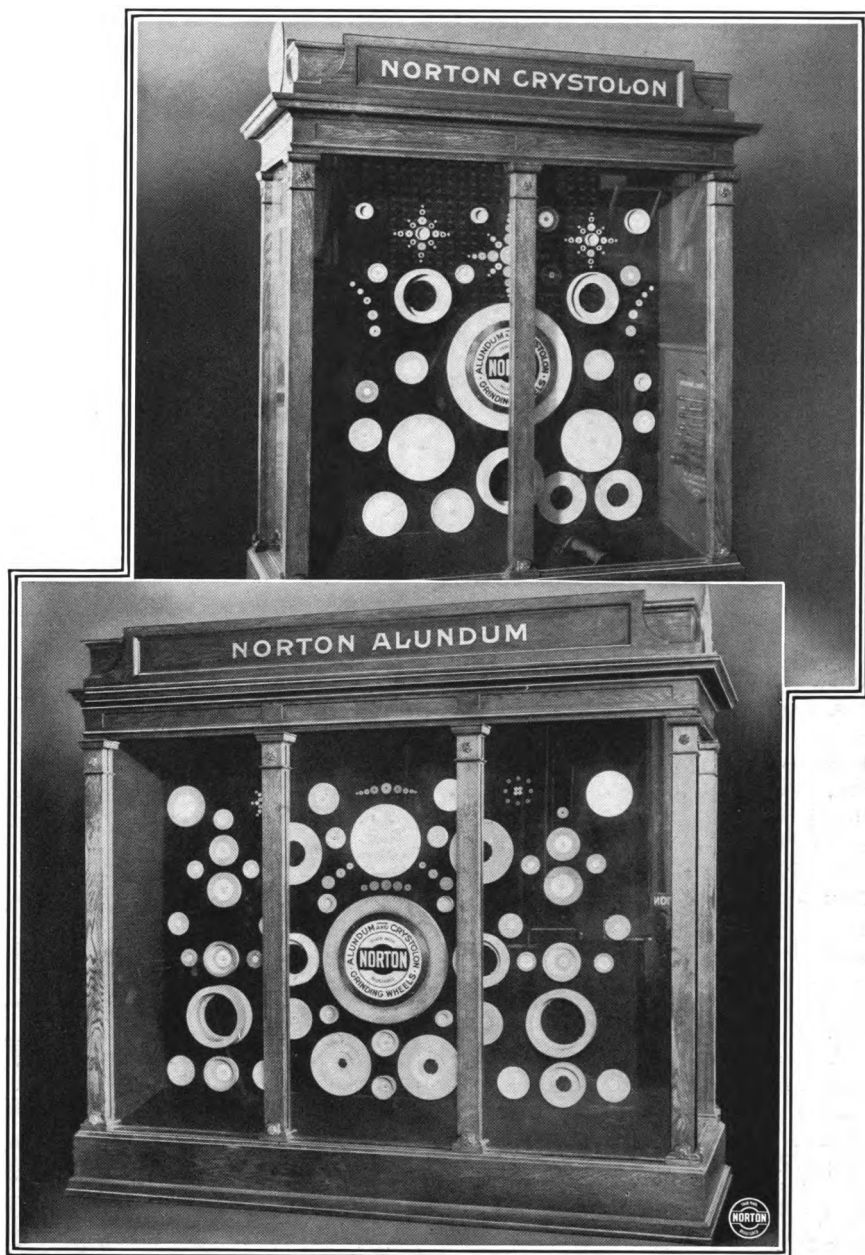
One is impressed upon entering the store with the business-like arrangement

and display of the various lines represented, showing that much thought and care had been exercised in this important phase of sales promotion.

The officers, C. C. Coventry, President and Treasurer; F. Conrad Wittich, Vice-president; and W. W. Kelly, Secretary, by a noteworthy progressive spirit and personality have so inspired the entire organization as to make of it a model for other business institutions. Their efforts have made them one of the largest Norton agents and, considering the extent of their territory, a leader in volume of sales. This success is due to their enthusiasm together with their ability to transmit this to their associates and to their policy of educating salesmen, specially for the grinding field, who devote practically their entire time to developing the grinding wheel department.



Norton Wheel Section in Store of Cleveland Tool & Supply Co.
Cleveland, Ohio



Display Cases of Norton Grinding Wheels
Cleveland Tool & Supply Co., Cleveland, Ohio



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Pratt & Whitney Co., Hartford, Conn., have brought out a new horizontal surface grinding machine which is described in considerable detail and illustrated in *Machinery*, Oct., 1913, page 146-147; *American Machinist*, Sept. 25th, 1913, page 541-542; *Iron Age*, Sept. 25th, 1913, page 656-657.

A heavy face grinding machine has been recently developed by The Diamond Machine Co., Providence, R. I. This machine is especially adapted for grinding locomotive guide bars. *American Machinist*, Oct. 2nd, 1913, page 583; *Iron Age*, Sept. 25th, 1913, page 661-662; *Machinery*, Oct. 1913, page 154.

A new roll grinding machine with many new features of design and construction is now being built by The Landis Tool Co., Waynesboro, Pa. The machine is built in various sizes for grinding rolls from 30" x 120" to 52" x 240". The grinding wheel is 30" in diameter with 3" face. *Iron Trade Review*, Aug. 28th, 1913, page 377-378; *Iron Age*, Aug. 28th, 1913, page 444-445; *Machinery*, Sept., 1913, pages 58-59; *American Machinist*, European edition, Sept. 13th, 1913, page 331-332.

A machine for grinding formed gear cutters is a recent production of the Cincinnati Gear Cutting Machine Co., Cincinnati, O. *Iron Age*, Oct. 9th, 1913, page 779; *American Machinist*, Oct. 9th, 1913, page 631; *Iron Trade Review*, Oct 2nd, 1913, page 580; *Machinery*, Oct., 1913, page 165.

Two new products of The Racine Electric Co., Racine, Wis., are a lathe center

grinding attachment and a tool-post grinding attachment which can be put to several uses, some of which are illustrated in *Machinery*, Oct., 1913, page 152-153.

A special internal grinding machine of unusual capacity, developed by The De La Vergne Machine Co., New York, is described in *American Machinist*, Oct. 23rd, 1913, page 685-686.

A portable grinding outfit involving the use of a flexible shaft of a new unit construction has been put upon the market by The Plank Flexible Shaft Machine Co., Grand Rapids, Mich., *American Machinist*, Oct. 23rd, 1913, page 714.

A heavy duty vertical surface grinding machine manufactured by Alfred H. Schutte, Cologne-Deutz, Germany, is described and illustrated in *American Machinist*, Oct. 16th, 1913, page 657-659.

A large piston ring and surface grinding machine in two sizes to grind 30" and 40" diameter respectively is a new product of The Churchill Machine Tool Co., Ltd., Manchester, England. *American Machinist*, Oct. 16th, 1913, page 671-672.

A new grinding machine made in the tool-making department of The National Transit Company, Oil City, Pa., for grinding large reamers, taps and milling cutters is described in *American Machinist*, Oct. 9th, 1913, page 618.

The Cincinnati Precision Lathe Co., Cincinnati, Ohio, has improved its line of friction-head bench lathes by fitting them to do cutter grinding as well as other classes of grinding and lathe work. *American Machinist*, Sept. 11th, 1913, page 458.

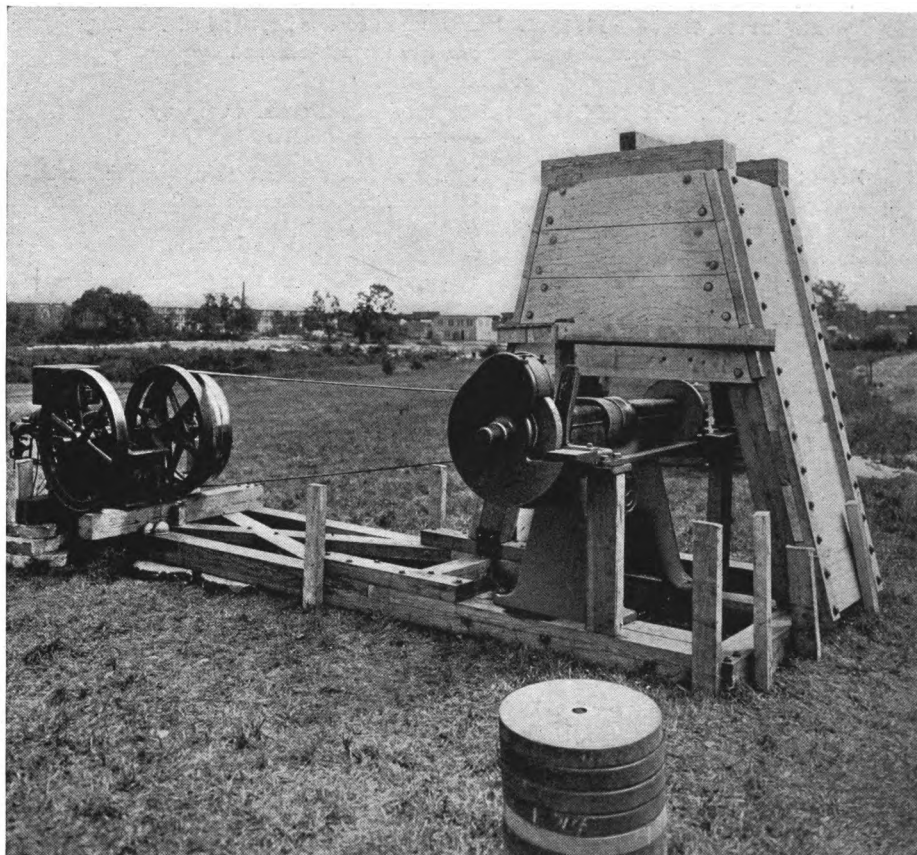
GRITS and GRINDS

A Bulletin on Grinding and Grinding Wheels
NORTON COMPANY and NORTON GRINDING COMPANY
WORCESTER, MASS.

1913

DECEMBER

1913



**ARRANGEMENT OF APPARATUS FOR TESTING PROTECTION HOODS
AND BEVEL FLANGES**



Grits and Grinds

Vol. V

December, 1913

No. 8

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Tests of Grinding Wheel Protection Devices

Paper Read Before New Haven Section, American Society of Mechanical Engineers, October 21, 1913. Description of the Method of Testing and Deductions from the Data Obtained

By R. G. WILLIAMS, Safety Engineer, Norton Company

Recent discussions in the technical press and publications devoted to industrial safety and welfare work have forcibly brought to the attention of those most interested the fact that there is no uniformity or standardization of grinding wheel protection devices. This lack of uniformity has been a serious handicap in the development of safer manufacturing conditions. Attention has also been drawn to the fact that there were no recorded data or observations on which standardization and safety rules could be based. With the purpose of obtaining data and observations on the relative protection offered by an approved type of protection hood and approved beveled steel flanges, the Norton Company, through their Research Laboratories, conducted a series of tests.

The testing equipment consisted of an up-to-date grinding wheel stand driven by a $7\frac{1}{2}$ H. P. gasoline engine. A wooden frame work of heavy timbers was built over the side on which the flanges were tested, to intercept pieces of the wheels which might possibly break off outside the flanges.

In all the tests the wheels were operated at 6000 peripheral feet per minute, the

speed being very carefully regulated immediately before each test.

Hood Tests

The wheels used for the hood tests were $16 \times 2 \times 1\frac{3}{4}$ " Alundum Vitrified of various grains and grades and had parallel sides. The hood was of modern type, and the wheels were mounted between relieved 8" diameter cast iron flanges. One layer of blotting paper of standard thickness was used between the wheel and each flange. The nut on the spindle was not tightened excessively, but drawn up enough to firmly hold the wheel.

The wheels in the hood tests were broken by dropping a steel wedge between the rest and the side of the wheel in such a manner as to provide a severe blow. The object was to duplicate as near as possible one of the most frequent causes of accident, that of the work being caught between the rest and the wheel.

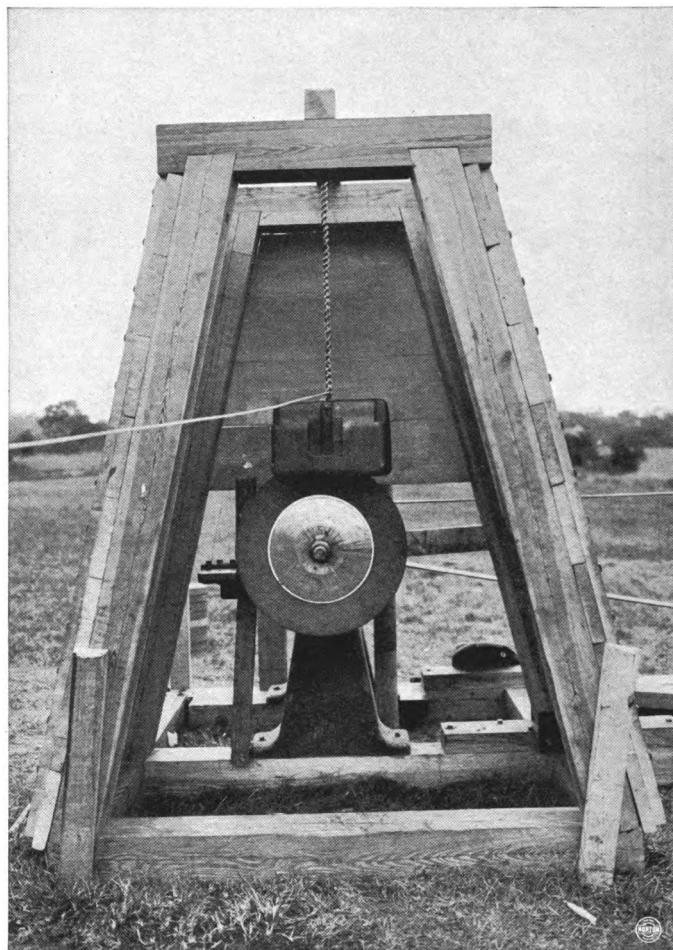
Flange Tests

The wheels used were all $24 \times 2\frac{1}{2} \times 1\frac{3}{4}$ " Alundum Vitrified, grain 14, grade 0, tapered both sides, $\frac{3}{4}$ " to the foot, with a flat at the center of 4" diameter. One thickness of standard blotting paper was



used between the wheel and each flange. In these tests, five sets of relieved steel flanges tapered $\frac{3}{4}$ " to the foot were used, of 12", 14", 16", 18" and 20" diameter.

which are suspended by tackle above the wheel, are carelessly allowed to strike the side of the wheel with enough force to cause breakage.



METHOD OF BREAKING WHEELS

The wheels were broken by swinging a cast iron weight weighing 130 pounds against the side of wheel. This method of breakage corresponds to a common cause of accident in grinding heavy castings where the castings are suspended by tackle above the wheel while being ground, coming in violent contact with the wheel when carelessly handled.

The wheels in these tests were broken by swinging a 130-pound cast iron weight against the side of the wheel. This method of breakage corresponds to a common cause of accident when heavy castings,

(The manner in which a wheel is broken is not important when protection devices for grinding wheels are being studied, so even though the wheels were broken by different methods in the hood tests and the



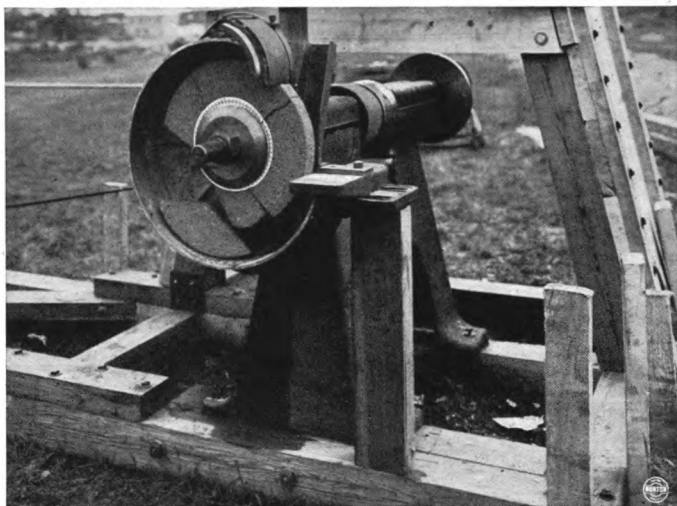
flange tests, the results obtained are comparative from the point of view of protection to an operator.)

Observations

1. In none of the hood tests did a piece of the wheel leave the hood in a way that could have caused damage. The tests show conclusively that a well designed protection hood, made of the right material, and properly adjusted, affords

nevertheless, the tests as a whole brought out a number of points which could be so used.

2. If specifications for hoods for rough grinding are drawn, they should not only require a certain strength as determined by the design and material used, but they should also require that the top end of hoods have some sliding-tongue device, which can be adjusted as the grinding wheel wears, and thus offer at all times



**WHEEL: 16 x 2 x 1½", Alundum 24-K Vitrified; speed 6,000 surface feet.
None of the broken pieces escaped from the hood.**

ample protection for straight-side wheels even when they are mounted between standard straight relieved flanges one-half the diameter of the wheel.

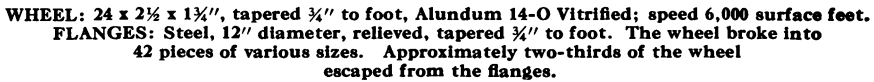
2. It is possible to break pieces from a wheel by a severe blow when there is only 2" of the wheel projecting beyond the flanges. With protection flanges, no matter how little the wheel projects beyond the flanges, an operator has no protection from injury in case a piece of the wheel breaks off outside of the flanges, whereas with a hood, protection is almost absolute.

Discussion

1. It was not the intention to obtain data from which standard specifications for hoods and flanges could be drawn;

the maximum protection possible. They should also contain a definite statement as to the maximum exposed grinding surface allowable for the common varieties of grinding. For example: Can 60°, 70° or 80° of grinding surface be exposed on the type of machine known as the floor stand? Such specifications should also state the minimum size wheel allowable in a hood of given dimensions.

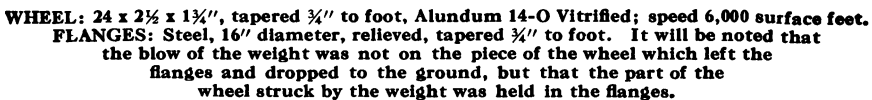
3. In a majority of instances where protection flanges are now used, ample protection can be obtained by means of hoods without such flanges. However, there are conditions where a hood is not practical and where flanges offer the next best method of protection.



the wedging action of a broken piece of the wheel.

B—The size of flanges.

C—Bevel of the wheel.





D—Peripheral velocity of the wheel.

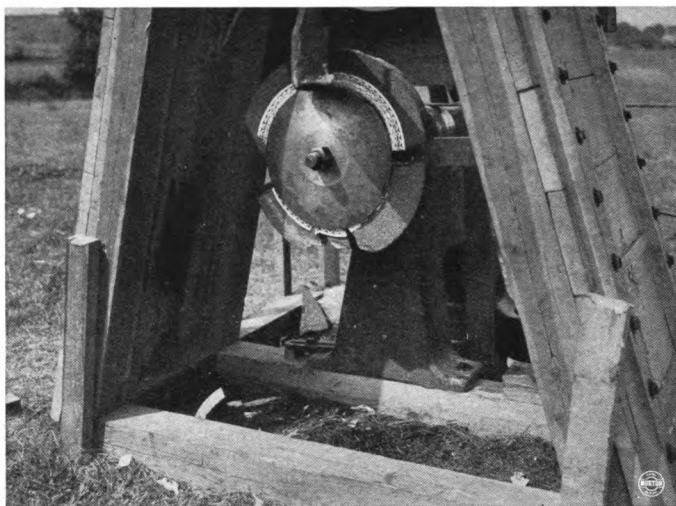
E—Mass of the wheel.

F—Degree of safety.

Degree of safety, as here used, expresses the relationship between the thickness of the wheel at the hub and the thickness of the wheel at the point where the outer edge of the flanges bear on the wheel. In other words, it is an expression which indi-

diameter flange test give a basis on which standard specifications may be formulated. The combination of factors present in this case resulted in what could be termed a critical condition.

The wheel broke into four almost equal pieces, the weights of which were about $23\frac{1}{2}$ pounds. The peripheral velocity of the wheel was 6000 feet per minute. The



WHEEL: $24 \times 2\frac{1}{2} \times 1\frac{3}{4}$ ", tapered $\frac{3}{4}$ " to foot, Alundum 14-O Vitrified: speed 6,000 surface feet.
FLANGES: Steel, 18" diameter, relieved, tapered $\frac{3}{4}$ " to foot. The piece of wheel shown on the ground outside of the guard was not knocked off by the blow of the weight, but was thrown away from the flanges by centrifugal force and hurled through the opening at the top of the wooden framework into the air about 50 feet.

cates how much the flanges must spread in order to let out a broken sector of the wheel.

1. If the force with which a sector tends to come out of protection flanges is great enough to spread the flanges, a distance of B minus A inches (see page 8), then a sufficient amount of protection is not present. Sufficient protection can be obtained by (a) increasing the thickness of the flanges, (b) using flanges of a material with a greater modulus of elasticity, (c) increasing the diameter of the flanges, or (d) increasing the taper per foot of the wheel.

Some figures obtained from the 16"

wheel was tapered $\frac{3}{4}$ " to the foot, the taper ending 2" from the center of the wheel. In order for a sector to fly out of the 16" diameter flanges, the flanges had to spread a total of $\frac{3}{4}$ ". After the breakage, it was found that the sectors had moved out a little over $5\frac{1}{2}$ " and the flanges had spread a little over $1\frac{1}{8}$ " or nearly the required distance to let out the sectors.

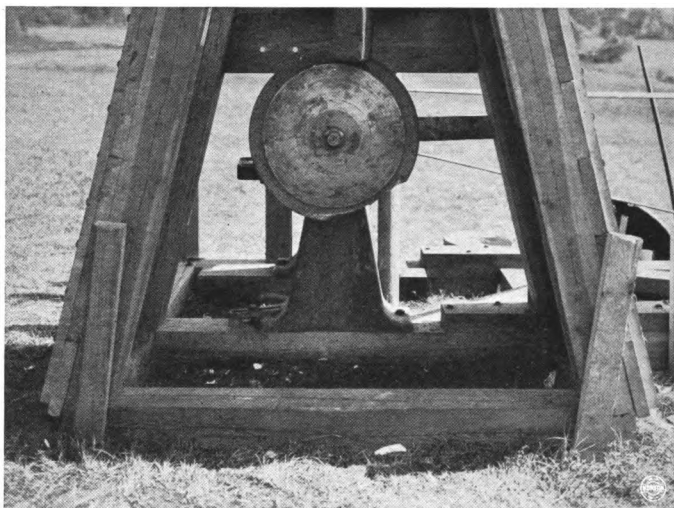
The shape of the flanges used was such that it has been found impractical to consider them as cantilevers of the same cross sectional area, and therefore, the acting forces in the above case and the exact factor of safety can not be readily calcu-

lated. For this reason we can not deduce definite formula relations between the several factors involved. When further tests are conducted, flanges will be used of a shape which will allow such calculations. We can, however, find a proportional relation which expresses the relative degree of safety with different size wheels and flanges.

3. Standard specifications should require a factor of safety of at least two. This requires a greater taper than $\frac{3}{4}$ " to the foot, or the use of very heavy steel flanges.

Conclusions

1. The tests conducted and the mathematical deductions given above show



WHEEL: 24 x 2½ x 1¼" tapered ¾" to foot, Alundum 14-O Vitrified; speed 6,000 surface feet
FLANGES: Steel, 20" diameter, relieved, tapered ¾" to foot. It should be noted that while only 2" of the wheel projected beyond the flanges it was possible to break off a portion of the projecting mass. Thus, the operator would be in more or less danger from these broken pieces.

2. 20" diameter flanges must open one inch to let out a sector. This distance is 33½% more than in the case cited above, so that 20" flanges of the same stiffness as the 16" flanges would just about hold the quarter sector of a wheel of 33½% greater mass. A 24" wheel of 33½% more mass than the 24 x 2½" wheel cited above would be a wheel about 24 x 3⅜".

Since 20" flanges are as large as is practical to use on wheels 24" in diameter, it is quite obvious that 24" wheels of a thickness greater than 3½" are not safely guarded by means of ¾" taper protection flanges, unless the flanges are made more rigid than most of the existing type of flanges.

that protection hoods provide greater safety than do safety flanges.

2. The protection offered by any given taper decreases with decreased diameter of the wheel. To provide equal safety on all sizes of wheels would require, therefore, a graduated difference in taper.

3. A hood with adjustable tongue furnishes equal protection for a wide range in the diameter of wheel.

4. Second to safety, the cost of operating a given grinding machine is of vital interest. In this respect adjustable hoods have the better of the argument for, as the wheel wears, protection flanges must be changed frequently. Such change involves the removal and remounting of the two



9. A proper hood offers complete protection. Protection flanges can not offer this complete protection, but in instances where a hood would interfere with the proper use of the wheel, flanges offer the next best method of protection.

Small wheels can be reamed with a round or square file or Alundum stick, rolling wheel on the bench until size of hole is what you want.



Safety Engineering Department

Norton Company Organizes a New Department to Specialize on the Problems of Safety in Grinding Operations

In this newly organized department will be centralized the activities of the Norton Company toward greater safety for grinding wheel operators. While the department is new, it is in reality but a concentration into one department of all the work toward safety which has long received serious attention and study by the Norton organization. For many years this company has endeavored to work effectively with manufacturers, state industrial departments and liability insurance companies.

The Safety Engineering department will be devoted solely to the consideration of the safety problems presented in the grinding field. It will make special studies to properly determine the relative value of different types of protection devices and will conduct an educational campaign for the benefit of all grinding wheel users. It will be prepared to furnish lecturers upon safety as applied to grinding wheels, before technical and commercial organizations.

It is hoped to make this department very useful to safety engineers and industrial commissions by co-operating with them in the conduct and operation of tests, under practical working conditions, from which should be secured the data

for formulating safety rules and safety legislation.

Dust exhaust systems will likewise be studied to aid in the solution of the problem of the menace to health caused by the inhalation of dust incident to grinding operations. Another field for activity will be co-operation with safety expositions.

It will seek to co-operate with manufacturers of protection devices and dust exhaust systems in an endeavor to standardize the specifications for such devices and appliances.

The work of this new department has been entrusted to Rich-

ard G. Williams, who for some time has been assistant research engineer of Norton Company. Mr. Williams is a graduate of Columbia University with the degree of B. S., did post-graduate work in metallurgical and chemical engineering and is a member of the American Society of Mechanical Engineers.

During the last five years, he has represented the Norton interests in the solution of many problems—particularly safety problems—arising in the grinding practice of large users of wheels and brings to his new work both this wide experience and the knowledge gained from extensive special investigations.



R. G. WILLIAMS, Safety Engineer

Dynamic Balance

**Description of an Interesting Test—Correct Marking to Find Heavy Spot—
Usual Method of Procedure—Rules for Operation—Balancing
Individual Members of a Revolving Body**

(CONTINUED FROM NOVEMBER ISSUE.)

An interesting experiment may be performed with a fairly light body which is quite badly out of running balance. Starting from rest, revolve the body at gradually increased speeds. Increase the speed as high as possible without running the risk of the body jumping from the machine. Watch the indicators. At first their swing or vibration is short. With increase in speed, the vibrations become longer until at a certain speed a maximum swing is reached. Suddenly, the indicators, with a quiver, come to rest *for an instant*. They again start to vibrate as soon as this "critical speed" of revolution is passed. The vibrations, however, are much shorter after this "change-over" has taken place. The vibrations of the indicators may be represented as shown in Fig. 7.

At all speeds *below* the critical speed, an unbalanced body will be marked on the *heavy* side.

At all speeds *above* the critical speed, an unbalanced body will be marked on the *light* side.

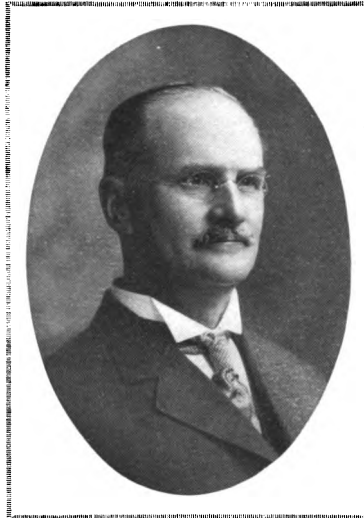
The mark, however, though on the heavy or light side as the case may be, is not at the exact heavy or light spot, but is displaced from its true position. The direction of the displacement depends upon the direction of revolution of the body; that is, if the mark is displaced in

one direction by revolving towards the right, it will be equally displaced in the opposite direction by revolving at the same speed towards the left, and, therefore, the true heavy or light spot lies midway between the centers of the two marks. See Figs. 8 and 9.

The critical speed depends upon the error and the weight of the body, but is always very low. The machine is, in most cases, operated by "running fast" (that is, above the critical speed), thereby marking on the light side. Marks thus obtained will be easy to strike and more distinct than those obtained when marking on the heavy side. The exception to this practice comes

when a part is either very badly out of balance or when it distorts, due to centrifugal force. Such a body may be balanced by running slow and marking on the heavy side.

An operator may know at any time whether the marks are on the heavy or light side, simply by placing arrowheads at the centers of the marks, as described and illustrated below. The crankshaft, shown in running balance in Fig. 5, is thrown out of running balance (notice vibration of indicator in Fig. 6), by the weight (A) of Figs. 8 and 9. The crank, if revolving below the critical speed, will have the marks on the side with the weight



CHARLES H. NORTON
Designer of Running Balance
Indicating Machine

as shown in Fig. 9; if revolving above the critical speed the marks will be on the side opposite the weight as shown in Fig. 8. The arrowheads indicate the direction of rotation for each mark. Revolve, say first, in a *right hand direction*. Make a mark with the scriber and stop the body. Then take a pencil and put arrowhead at the center of the mark, pointing *toward the right*, that is, in the direction of rotation. Now, revolve the piece in a *left hand direction*. Make a second mark with the scriber, keeping this mark separate from the first. When the piece has stopped revolving, put an arrowhead at the center of this second mark, pointing *toward the left*. Be sure the arrowheads are *at the centers of the marks*. From a study of the "arrowed marks" shown in Figs. 8 and 9, the following facts may be noted.

When marking on the *heavy* side (Fig. 9) the marks *lag*; that is, they are behind the exact heavy spot when the direction of rotation for each mark is considered.

When marking on the *light* side (Fig. 8) the marks *lead*; that is, they are ahead of the exact light spot when the direction of rotation for each mark is considered.

When marking on the *heavy* side, the arrows point *toward* each other.

When marking on the *light* side, the arrows point *away* from each other.

The arrows *always* point toward the weight, no matter whether they are on the heavy or light side.

The operator should keep in mind these two simple rules.

The true *heavy* spot lies midway between the *points* of the arrows.

The true *light* spot lies midway between the *bars* of the arrows.

The usual method of procedure is as follows; Revolve the piece fast enough to mark on the light side with the arrows pointing away from each other. Of course, the true heavy spots (one at each end) lie directly opposite the true light spots. Watch the indicators for they tell whether both ends "are out" about the same, or whether one end is worse than the other. Mark both ends, unless

one end should happen to be in balance, in which case only mark the bad end. If stock is to be removed, drill out or "snag" off from each heavy spot near the ends what you think is necessary. Place the part back in the machine, and it will be seen that the "out of balance" condition is very much improved. Mark again and remove the stock. Repeat these operations until the piece revolves without any appreciable vibration or with no appreciable movement of the indicators. For commercial work it is not necessary to balance until the body is marked "all around." If weights have to be fastened on, at the light spots, have a number of differently sized pieces of sheet lead. Use these as temporary weights. Fasten them on securely with hardware twine. When enough lead has been added to the light spots, weigh (cheap candy scales are good enough) each bunch of

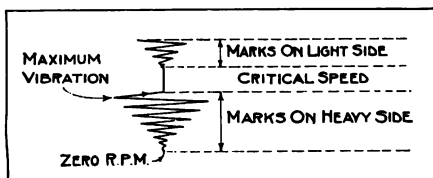


Fig. 7

lead separately and fasten on the equivalent permanent weights. Oftentimes, with very heavy pieces, such as extra large flywheels, it is quicker to put on temporary weights and then drill out the required stock at one operation. When there is a large number of parts of the same kind, a workman with a little experience is able to judge by the movement of the indicators about how much stock to remove or put on. He generally will strike a balance with two or three attempts.

It is very seldom that one will need to run slow (below the critical speed) and mark on the heavy side. Some six-throw crankshafts are so long and slender that they bend when revolved, even at the slow speeds. They may have to be marked on the heavy side.

Do not revolve a six-throw crank on

both end bearings. Revolve it on one end bearing and one inside bearing. In this position the tendency of the shaft to bend is slight. With four-throw cranks, revolve only fast enough to mark on the light side. Never try to mark a shaft when you can see it bending to any extent at the middle.

Of course, if a piece bends or is in a bent condition or is "out of round" the marks will not indicate the true light

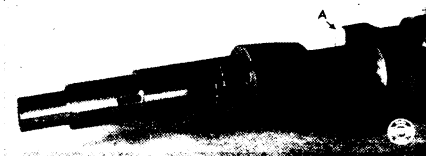


Fig. 8

side. Always make the marks on a surface which is smooth and which runs true with the center of the piece.

Always follow the marks as the part approaches a condition of running balance.

Remove or add stock as near each end of the body as possible. A correction at the ends is most effective.

Remember that a part in running balance at one speed is in running balance at all other speeds, provided it does not distort from centrifugal action.

Many automobile makers who send their revolving parts to the Norton Grinding Company in order that the Company may demonstrate the running balance indicating machine for this work, will send the crankshaft and fly-wheel put together and made so that it is practically impossible to separate them to balance the parts, and be able at the same time to replace them and have them run true and consequently in balance. They almost invariably omit to send the other revolving parts, that is, the clutch and any other parts that may be revolving on the same axis. Then, when testing out these balanced parts afterwards, they put onto the same axis the parts that have not been

put in running balance, and therefore they do not get good results.

The very fact that a thing is in balance settles the question as to its being changed in form afterwards. That is, balancing must be the very last thing done to that object, if we would still maintain running balance. It goes without saying that a fly-wheel or a crankshaft, if put in running balance, cannot be turned up on the shaft afterwards in order to true it.

To be successful with running balance, each individual member of a revolving body, like the crankshaft, the fly-wheel and the clutch, must be made so accurately that they will run perfectly true, whether they are running separately or assembled. There is no such thing as balancing objects and then putting them together and truing them up in place. The truing will destroy the balance, and it is not correct to balance these objects when they are all put together, for the reason that one can never tell whether he is balancing that object by itself or whether he is balancing it by placing weights or removing weights from another member that does not require balancing, and therefore, setting up bending strains between the fly-wheel and the crankshaft, clutch, etc.

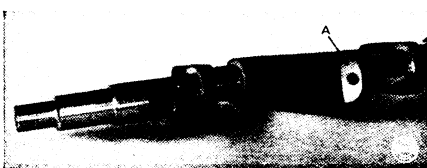


Fig. 9

The only way to have a good running balanced crankshaft, fly-wheel and clutch is to so construct these three members that they will run true within the limits required, whether they be together or whether they be separate, and then balance each piece by itself.

The following table of differently sized holes to remove one ounce of either cast iron or steel may be useful.





Some Interesting Window Displays

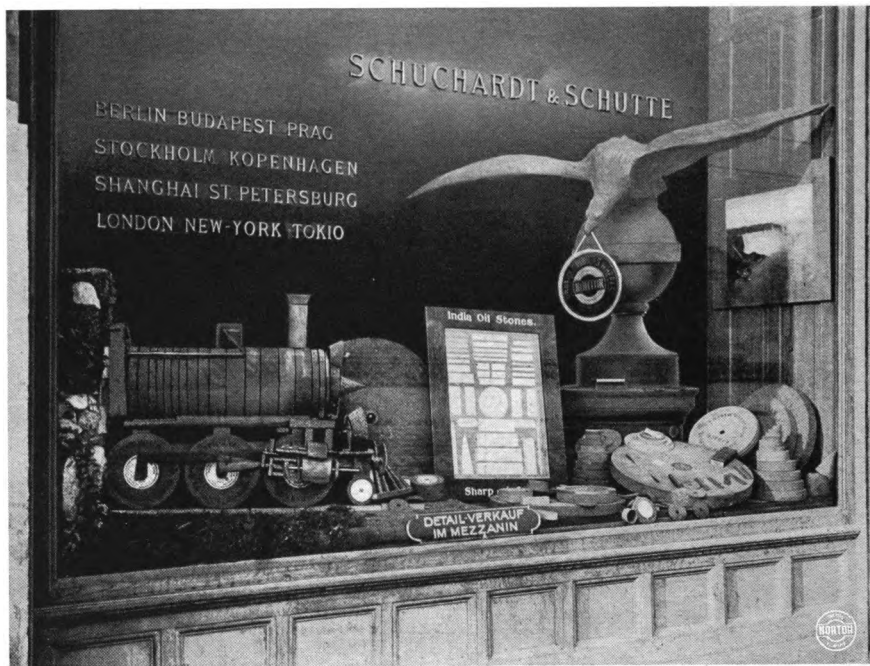
Illustrations of Displays made by Norton Dealers Which Demonstrate How Effectively Norton Products Are Used for Window Dressing

In this number of "Grits and Grinds" appear several views of window displays, showing how effectively Norton agents are using Norton products to make attractive windows. The unique display made by Schuchardt & Schutte in their Vienna store shows that there is opportunity for the expert window dresser to depart far from the beaten path in the display of grinding wheels and abrasive products.

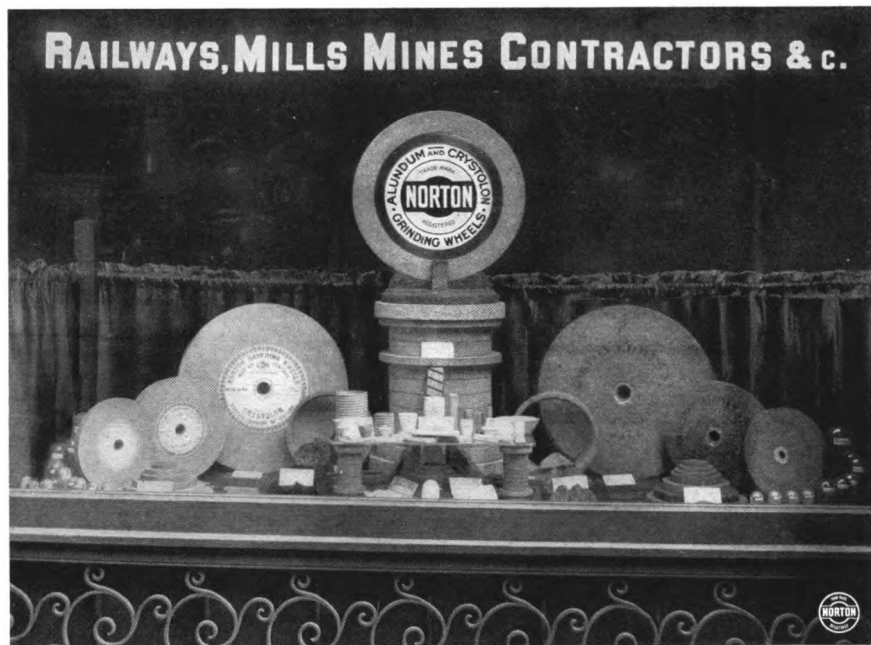
The window displays of Schroeter Bros. Hardware Co., St. Louis, Mo. The E. A. Kinsey Co., Cincinnati, Ohio; and the

Western Iron Stores Co. of Milwaukee, Wis., are of a type that never fails to draw the interest of the passing public. The varied shapes of the Norton products, and the brilliancy of the coloring of the crystals from which Crystolon wheels are made lend themselves to this type of advertising with excellent effect.

It is also interesting to see how well the agents and dealers are co-operating with Norton Company in its efforts to spread the knowledge of Norton products and Norton quality in the field of grinding.



Schuchardt & Schutte, Vienna, Austria.

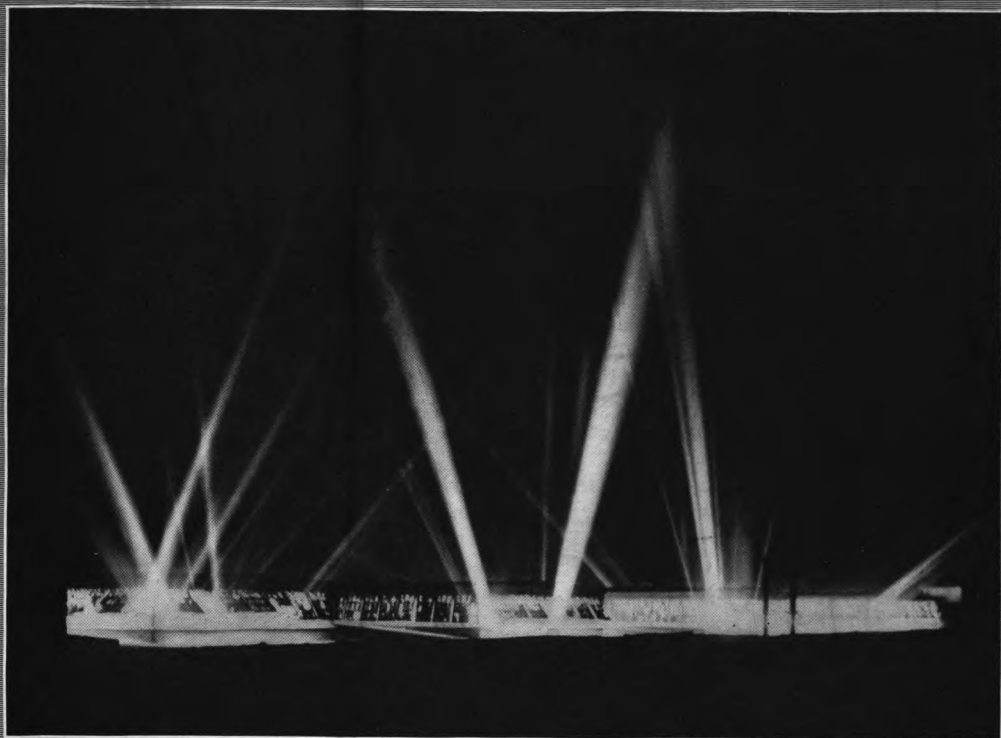


Upper—Schroeter Bros. Hardware Co., St. Louis, Mo.
Lower—E. A. Kinsey Co., Cincinnati, O.



GRITS and GRINDS

JANUARY 1914



NORTON ALUNDUM PLANT
AT NIGHT - NIAGARA FALLS, N.Y.
THIS VIEW SHOWS HOW THE RAYS
FROM THE POWERFUL ARC FURNACES
PRODUCE A STRIKING ILLUMINATION



GRITS and GRINDS

Vol. V

January, 1914

No. 9

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The Efficient Operation of Grinding Machines

The Variables that are Important Factors in Determining the Capacity of a Grinding Machine—Qualities of Materials Complicate the Problem—The Attitude of Operator and Employer

BY JOHN C. SPENCE, Superintendent Norton Grinding Co.

It is with trepidation that I undertake the task of submitting to you any ideas whatever on this subject. Mr. F. W. Taylor, the man who brought into prominence the modern efficiency movement, spent twenty-six years in formulating laws and methods concerning the art of cutting metal. During that time, there were carried on and reported over 30,000 experiments, and over 800,000 lbs. of steel and iron were cut into chips at a total cost of more than \$150,000.

The result of this great expenditure of time and money was the formulation of laws governing the operation of metal cutting tools on roughing cuts only.

The efficient operation of grinding machines is just as broad a subject and it would be folly to attempt to go into the question in any other than the most general terms, and the pleasure and glory of the establishment of the laws of grinding yet lie before the man who has the requisite knowledge and opportunity to experiment. The definite formulation of the idea of "grain depth" of cut by Mr. G. I. Alden, manager of the Norton Grinding Co., together with the vast experience that Mr. Norton has put into both his designs and his writings, has

laid the foundation for a work that should be the equal of that done by Taylor and his colleagues.

In Taylor's problem of the lathe there were twelve variables that had to be solved before he could arrive at a scientific basis of estimate concerning the capacity of a given machine. In plain cylindrical grinding we have several variables as follows:

a The quality of the substance which is to be cut, i. e. the degree of resistance to cutting. This again is due to various causes such as hardness, as in the case of hardened steel, toughness as in the case of manganese steel, extreme elasticity as in the case of soft rubber, and the faculty of loading the wheel as in the case of very soft metals such as soft babbitt.

b The rigidity of the work. This is usually expressed by the proportion of cross section to length. This again calls into play the variable due to the effect of steady rests and the design of the rests themselves.

c The grain depth of cut.

d The kind of wheel as to material of which it is composed, and the size of its cutting particles.

e The amount and kind of cooling or

lubricating compound that flows onto the wheel and work.

f The duration of the cut, i. e. the time that the face of the wheel must continue to give satisfactory results without re-truing.

g The changes of work speeds and wheel speeds and work traverses possible in the machine.

h The pulling and feeding power of the machine.

In addition to all of this it must be borne in mind that the grinding machine differs from all other stock removing machines, in that its product is, almost without exception, a finished product, so that, in addition to all of the problems that the lathe operator faces, the grinding machine operator confronts that greatest problem of all, namely, to lay down piece after piece of such a quality of finish, straightness and dimension as the world does not demand from any other machine operator, and to do this at a speed that is nothing short of marvelous when compared to other human accomplishments of like accuracy.

The problem is often further complicated by special qualities of some materials, such as cold rolled steel—drawn brass and bronze bars—forgings of peculiar shapes—and tubes of all kinds of metal. These pieces, especially, seem to be filled with little devils of contrariness that league together to spoil the record of the operator.

This, then, is the field in which the pursuer of truth in the grinding business must work. Looking at this problem from the viewpoint of a factory superintendent, without prejudice as to make of machine, I will try to enumerate the essential points that must influence efficiency in grinding in the order of their importance. These are:

- a* The machine itself.
- b* The ability and spirit of the operator.
- c* The attitude of the employer.

d The condition in which the work comes to the grinding machine.

e The facilities for handling the work.

First: The machine itself.

In considering the question of efficiency, we must of necessity take into account a long period of time. The demonstrator may be very efficient for the short term he stays with a machine and yet the machine itself prove a failure because

the profits of a business are figured by the year and the efficiency of a machine is nothing more nor less than its ability to earn profits. In order to do this, the stops for repairs and all other causes, such as handling of work, adjusting of speeds and steady rests, and even the simple matter of oiling, must be the least possible for the year.

The machine that gives, then, the greatest number of productive hours per year at a given rate of acceptable output is the best machine. This quality can only be obtained by generosity of size



JOHN C. SPENCE
Superintendent Norton Grinding Co.

and weight in the design and by strict attention on the part of the designer to the laws of truth. It will not allow of any bowing down to the demands of the convenience of some one prospective customer and the man who buys such a machine must, of necessity, pay more for it than he would have to for a machine sold on price only.

The machine, then, must be one capable of bearing without undue deterioration wheels of wide face as the rate of stock removal depends directly on the number of wheel particles in action at a given time. If the quantity of the work is sufficient to warrant the purchase of the wheel, and the limit is not less than .0005", it does not pay to use a traverse on those portions of a shaft that are less than 5" long. For this width of wheel, the machine should weigh at least 6,000 lbs. Such a wheel will produce about three times as much work as will a wheel of two inches in width on a cut of 5" in length. Theoretically it would produce only about $2\frac{1}{2}$ times as much, but the 2" wheel must be so manipulated as to overlap its own cut at each revolution of the work, and time is also lost at each reversal of the table.

This disadvantage could only be overcome by higher rate of work traverse and corresponding increase in work speed. The inertia of the traversing parts is, of course, the limiting factor.

If the work is small in diameter and so long as to be flexible, say $\frac{3}{8}$ " diameter by 10" or more in length, it will pay to use a light machine, provided the output is equal to that of the heavier machine. The economy lies in the fact that interest, depreciation, power and rent charges are less for the small unit.

The average run of shafts, however, does not approach this class and, in general, the heavier machine is the better bargain. The exceptions come in special industries such as the manufacture of comparatively small machines.

The rule then is "never traverse the work when the machine will stand a

wheel wide enough to make the cut, and always use the widest possible wheel when traversing, and take full advantage of the wheel width by rapid work traverse." The following of this rule will require a little change from the commonly accepted grade of wheel for a given piece of work, as the wide wheel will have to be softer provided the limit of power has already been reached in the use of the narrower and harder wheel.

Practically the only mechanical trouble with a grinding machine that is heavy enough for its work comes through abuse of the spindle, either by neglecting to oil, using improper oil, or failing to adjust the bearings when worn. To eliminate this trouble the Norton Grinding Company has adopted the plan of having one man attend to all of the oiling and repairs on the twenty-five heavy machines in operation in its works. The good results may be judged when I tell you that we do not have to re-scrape over one spindle bearing per month, and several spindles have run for at least three years without any other attention than proper oiling.

This shows remarkable qualities both in the design and material when it is known that the surface speed of the spindle is about 1,200 ft. per minute, and the difference in diameter between spindles and bearing is only .001".

In order to eliminate delays due to breakages in belts, the belts are standardized as to length, where possible, and extra sets are kept in readiness.

b The ability and spirit of the operator.

Without fair ability and a co-operative spirit on the part of the operator, all efforts towards efficiency are of little effect. The chap who is always playing you in the hope of getting prices set too high so that he can do as little as possible is only too common and is his own worst enemy because once he is discovered there is a feeling of distrust of him in the mind of his foreman, and he is the fellow who is never trusted to do experimental work, or any work which must be done at day rates due to extreme



requirements of accuracy or for other reasons.

Of course, the proper policy to pursue with this kind of man is to never give him a job that has not already been tried by an operator who is honest and on whose production the piece price has been based. On the other hand there are many operators who pay conscientious attention to the finer points of grinding and whose work is nearly always within the limits and runs true when tried on centers. The bare record of the grinding operation would make it appear that this kind of man was not a fast operator and, were he judged by books alone, he would have to be replaced. Judged from the standpoint of honest work that adds to the reputation of the concern, and from the fact that he usually needs very little supervision, he is almost always a better man to keep than the rapid producer of whose work the inspectors are always suspicious.

c The attitude of the employer.

A grinding department should be a well lighted pleasant place to work in. You are asking your operators to perform really wonderful work and unless you foster the spirit of pride in good work and neat surroundings, your product will not be first-class. Good work comes from inspiration and enthusiasm and cannot be forced out of anyone.

The bugaboo of wheel wear and diamond wear is another false notion. The man who burns gun-powder to get a rabbit in preference to shooting it with an arrow and then extracting the arrow for future use, does not regret the fact that he has used the powder because he knows he can get enough more rabbits to make powder burning pay. Yet the same man fails to comprehend that, as a general rule, it pays to true wheels just as Taylor found that it paid to run lathes so fast that the tool would have to be ground at short intervals.

In other words the time lost in truing plus the wheel and diamond wear are usually investments that pay, and in much more practical form than rabbits.

The usage of having only one diamond for several operators is also bad practice as no man who takes an interest in his work likes to share a tool that he, left to himself, would keep in good condition, but which, being common property, is not cared for because of distributed responsibility. Unfortunately, this question is often settled by a purchasing agent instead of by an engineer.

The setting of piecework prices by estimate is another point to be avoided. It is, of course, necessary for someone to estimate all operations and this is sometimes the only way in which probable costs can be arrived at, but no one man can, without doing occasional injustice, make grinding prices by estimate.

The time for grinding a given piece is influenced by so many conditions that the only safe way in which to arrive at a fair time is to have a trial lot of pieces ground by someone of fair ability who represents the shop management.

The management should then be satisfied to get this output, day by day, and if, by skill acquired in repeatedly performing the same operation, the operator is able to increase the production, he should be given the full benefit thereof and the management should rejoice with him instead of discouraging him by a cut in price.

d The condition in which the work comes to the grinding machine.

This phase of the grinding question gives the shop many opportunities to save money that are not now taken because of lack of co-operation between the lathe foreman and the grinding foreman. The best practice is to have the grinding foreman in direct charge of all turning that precedes grinding, and then to aim at the lowest price for the finished piece instead of having each foreman working independent of the other.

The best savings by the use of the heavy modern grinding machine can be accomplished by rapid, coarse turning that does not call for accuracy on the part of the lathe operator and which gives the

heavy, wide faced grinding wheel more to do. The corrugations, left by the lathe run at a coarse pitch are merely the points of little triangles, and are easy work for the grinding wheel.

Each piece of turned work should be studied individually and the decision made and recorded as to the way it should be turned and ground. Many pieces instead of being turned in one chip at a light feed may show a gain if two coarse feed chips are taken and as much as .050" stock left on diameter, measured on the tops of the triangles. With a feed of 15 turns to the inch these triangles are about .012" high, leaving .026" diam. solid stock to remove. Experience alone can tell how much total stock to leave and each case is as worthy of investigation as is any good investment.

Many pieces, such as crankshafts, bronze bushings, etc., are now being ground direct from the forging or casting without having been turned at all. This method was first made possible through the building of heavy grinding machines and seems, together with the increase in width of wheels, to be the direction in

which cylindrical grinding is growing most rapidly.

The shop should be trained to respect center holes and to make generous ones. The purchase and careful maintenance of a good accurate centering machine is a necessity. We inspect our centering machine several times a week and have a close limit of accuracy which, if not shown, calls for immediate repairs.

e Facilities for handling work.

Most factories have seen the wisdom of providing special trucks or truck bodies for their product as it not only assists the operator in handling the work, but is absolutely necessary if the finished product is to be kept from damage.

I would, therefore, recommend the trial, at least, of the items here listed, and furthermore, it is to the benefit of both the users and the maker of grinding machinery if the user would send in his turning and grinding problems.

While the machine maker may not always be able to improve production, yet the fact that he is continually thinking along these lines gives him some advantage over the general manufacturer to whom grinding is only incidental.

1914 Sales Conference

Another Norton Sales Conference—by far the best conference in the Norton annals—has passed into history. From Jan. 5th to Jan. 10th, groups of 60 to 100 men discussed the problems of the year just gone as well as those that will demand attention during the current year.

It was eminently a time of discussion; set, lengthy papers were absent; experiences, opinions, suggestions and friendly criticism were set forth by one and all with such freedom, earnestness and enthusiasm that the hours outlined in the program were exceeded in many cases. The program called for adjournment at 4 p. m. Friday but there was such interest in certain unfinished topics that an added session was held on Saturday morning.

With many concerns, the sales conference is devoted almost wholly to study of selling methods, market conditions and competition. The sale of grinding wheels is not simply a merchandising proposition—it is linked up with engineering problems that are ever present in grinding practice. At a Norton sales conference the subjects may vary from a descriptive paper on "Grinding Wheels in the Glass Industry" to a highly technical paper on "The Relation of Wheel Speed to Production and Power Consumption."

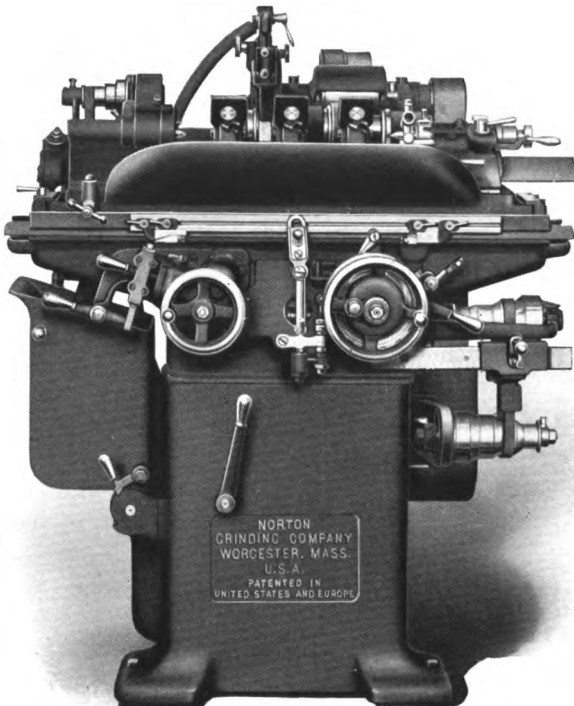
In the grinding field, where fundamental laws are few—where experience is the foundation for convictions that vary as the experience varies—it is always easy to start a warm discussion about almost any phase of grinding practice and so dull

moments are rare in a Norton gathering of sales and manufacturing forces. It requires no great imagination to glimpse the discussion that follows his address when Charles H. Norton in his characteristic manner talks on the topic "How to Select a Wheel to Suit a Customer Who is Grinding Manganese Steel vs. How to Grind Manganese Steel."

Our sales conference is designed for these purposes: To help our factory men to understand grinding problems; to keep our salesmen in touch with new develop-

ments in the grinding field and in our manufacturing processes; to foster the "family" idea—the "Norton spirit"—so that suggestions from any source—sales, office or factory—will be welcomed and given due consideration by the other departments; to gather into an active, powerful unit all the forces that together will push our products until Norton wheels, Norton machines and Norton service are known everywhere and their merits acknowledged.

3" × 18" Grinding Machine for Cylindrical Work



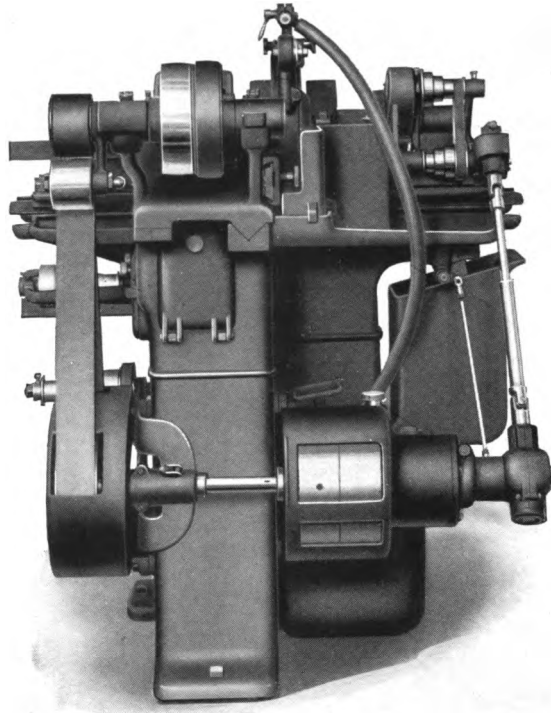
3" x 18" Machine—Front View

The most recent development by the Norton Grinding Company in cylindrical grinding machines is the advent of the 3" x 18" self-contained cylindrical grinding machine shown below.

[JAN. 1914]

It has been designed to grind small diameter work, and particularly for making finishing cuts where there is not more than .004" to .008" to be removed from the diameter of the work. The machine

[7]



3" x 18" Machine—Rear View

is particularly well adapted for work from 1-8" to 1-2" in diameter, although work up to 1" in diameter can be satisfactorily ground. It is especially useful in grinding such small parts as are used in sewing machines, electrical apparatus, phonographs, adding machines, typewriters, and in the manufacture of twist drills, reamers, plug gauges, and tool work. The machine has been designed to swing 3" diameter to allow sufficient room for the application of steadyrests. The maximum capacity of the table between centers is 18".

This machine can be fitted with a live spindle attachment, radial truing device, and center grinding attachment. The use of the steadyrests in this machine is identical with the method used in the larger types, and the same laws of steadyrest-

ing are applicable, even to a more noticeable degree, because of the lightness and slimness of the work for which the machine is designed. The steadyrests, three of which are ordinarily furnished with each machine, are provided with micrometer stops, permitting of very accurate adjustments, and being especially designed for small work are extremely well adapted to rapid and quick handling of parts. They are furnished with one set of hardened steel workshoes for handling one diameter of work. The shoes are designed with a view to quick changes from one size or diameter of work to another, and are well constructed, permitting of convenient and rigid supports for long, small diameters of work.

The center grinding attachment is

ordinarily supplied to grind the center points perfectly round and true to a 60° included angle. This, however, can be varied, and attachment for grinding different angles supplied, when so specified.

The radial truing device is similar in design to that used on the larger machine. It is used in truing the corner of the wheel to a radius necessary in producing fillets in the corners of shoulder work. Surprisingly accurate results can be accomplished by the use of this device. It is designed to be quickly attached and detached by the simple operation of a screw clamp.

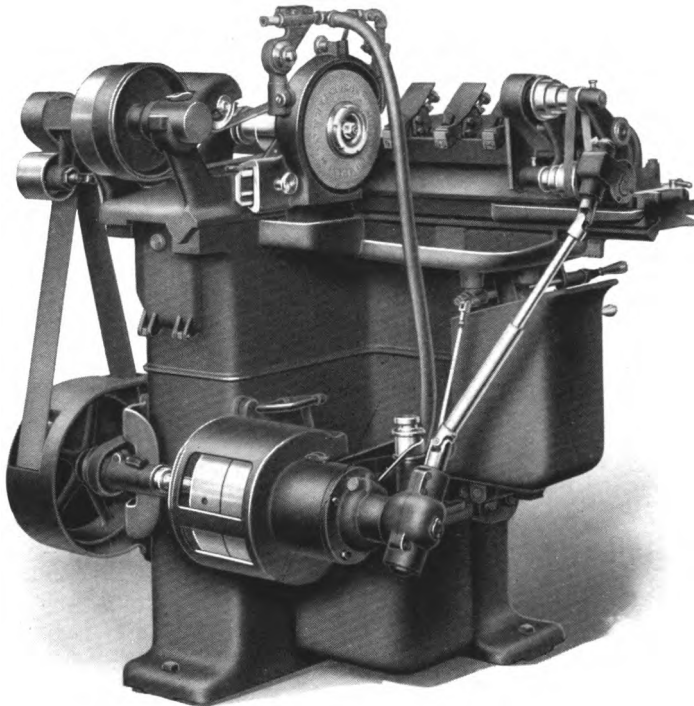
The machine is always ready to run as soon as the driving belt is in place, it being self-contained and no overhead works required. The drive is by belt, either from above or below, or by a motor

placed on the floor at the back of the machine.

The table is of the swivel type and provisions are made for grinding tapers up to 2" per foot. The table reverses very smoothly on high speeds and short strokes. This follows from a very ingenious mechanism which pneumatically cushions the reversal, under which conditions it is possible to operate the table at a speed of 27 feet per minute with absolutely no jar or noticeable change of speed as table returns.

Eight table speeds are provided which are easily changed by a simple speed changing device in the form of a belt shipper and especially shaped cones, the slowest of these speeds being 17" per minute.

The hand cross feed for this new machine differs considerably from the feed



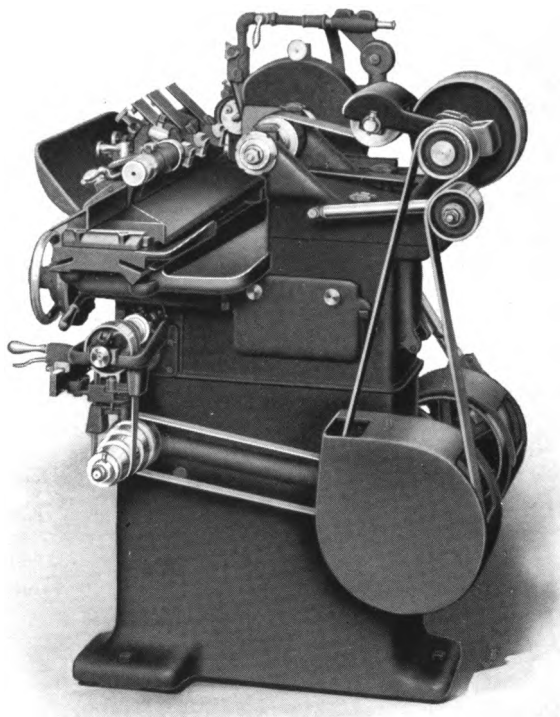
3" x 18" Machine—Left Hand End View

used on the larger types of the Norton cylindrical machines, but it still maintains the same degree of accuracy in sizing the work.

The simple moving of a little lever from one position to another position, 90° away, makes it possible to allow for a dwell at each end of the stroke of the table, permitting the necessary time for

and the work allowed to revolve. Stopping the table also connects the hand wheel for moving the table by hand and this hand wheel is automatically disconnected when the table is again started. This control is rather unusual and unique and is quite a factor in sizing small parts accurately, in so short a time.

The standard wheel used on this machine



3" x 18" Machine—Right Hand End View

finishing up the ends of slowly revolving work.

The table traverse is controlled separately or in conjunction with the revolution of the work by the simple operation of two levers at the left of the machine. The act of stopping the work revolving always stops the table traverse and the table cannot be started unless the work is revolving. Still the table may be stopped

is 10" in diameter, with $\frac{3}{4}$ " face. Proper wheels are furnished with each machine, for grinding soft steel and tool steel, cast iron and hardened steel. Although the standard wheel is $\frac{3}{4}$ " face it of course is possible to use a considerably narrower wheel, and slightly wider, if special work so demands.

The footstock is supported on the table by a broad, flat, dove-tailed surface which

gives a good solid contact, insuring perfect alignment of the centers over a long period of time. The footstock completely covers the dove-tailed ways on which it slides, thus protecting them from damage. The footstock spindle, in common with a number of other parts of the machine subject to wear, is of hardened steel which insures satisfactory wearing properties.

The headstock is rigidly fixed to the table. It has four work speeds, ranging from 160 to 640 r. p. m.

The wheel spindle, as in all other types of Norton grinding machines, is of chrome nickel steel, carefully heat-treated within very close limits for hardness.

All shafts are self-oiling and the loose pulleys run on self-oiling roller bearings.

A centrifugal pump provides an ample supply of lubricant on the wheel and on the work. This lubricant is drained off the machine into a settling tank which is conveniently located at one end of the machine in such a manner that it is out of the way and still accessible. It is pivoted at the bottom and held in place by a locking pawl. By lifting this pawl, the tank can be tipped over, emptied and very easily cleaned.

Changes in speeds can be accomplished without stopping the machine. The rapid table traverse, with the relatively wide wheel, makes rapid production possible

in finishing light, small work. Recently a 5-16" diameter steel shaft, 17" long, was being ground, removing approximately .008" and to a limit of .0005". This work was performed so rapidly that the operator did not have sufficient time to remove the driving dog from one piece of finished work and place it on a piece of unfinished work, while the machine was grinding one part.

The machine is very neat and compact in appearance and occupies a small floor area of 5' 10" x 3' 8", making it possible to place a battery of these machines in a department where, on certain classes of work, one operator can operate two machines. The weight of the machine is approximately 2,000 pounds.

The same careful workmanship is carried out in the construction of this small machine that has won a reputation for the larger types of Norton cylindrical grinding machines. All moving parts and parts subject to wear are provided with the most careful facilities for oiling. Sliding contacts are carefully protected from dust or dirt that might settle on them, and guards are provided for protection from grinding lubricant. Large revolving parts affecting accuracy in the machine are carefully balanced. All of these features help to produce a machine which will consistently turn out accurate work efficiently.

The Modern Grinding Machine and Its Service to the World

By CHARLES H. NORTON

Service is probably the keynote to success in any line of endeavor. Many of us can remember the time when in manufacturing and mercantile circles service was not thought of. The question in everyone's mind was simply, what can I get for this object which I have for sale, and little thought was given in those days

to the matter of service. We have learned in the last forty years that there is little, if any, value to any merchandise or any article of manufacture that does not render real service to the purchaser, and to-day we understand, as we did not formerly understand, that to be of any value a contract must be of mutual advantage.



As we read our history and hark back through the centuries to the days of the monks of Europe, we think of them as a lot of superstitious and useless leeches on society, and, of course, they were to a certain extent. But did you ever stop to think that it was the monks of Europe who gave us the foundation for the science of horology, or the science of measuring time? It was the monks who invented the first mechanisms for measuring time, clocks in various forms—hour clocks, clocks with tooth-gearings and clocks with the pendulum. It was the monks who wrote the first word explaining the principles involved in the mechanisms for measuring time, and the science of horology appears to be one of the first sciences that the world knew that dealt with matters of precision, and was probably one of the first valuable services to mankind.

And in the history of our own country a large proportion of the men who rendered the most mechanical service to their time and generation were first educated in the science of horology and clock making. It is perhaps a little significant that the first two men to introduce cylindrical grinding to the world were clock and watch makers. Mr. Joseph R. Brown, who, perhaps, rendered the greatest service to his time as a refined mechanic, was originally a clock maker, and moved from Pawtucket to Providence to engage in the manufacture of clocks. The invention of the sewing machine threw much refined work in his way, and he found it necessary for him to take up the manufacture of sewing machines. In so doing, he conceived of a cylindrical grinding machine, or the well known Brown & Sharpe Universal Grinding Machine.

Mr. Ambrose Webster, another early-time mechanic, was a watch maker and he gave to the world perhaps the earliest cylindrical grinding machine of which we have any knowledge. With it he succeeded in doing some very excellent work in the construction of watch machinery.

When you go down to breakfast in the

morning, and your cook serves you that very healthful morning food called Shredded Wheat, you may be interested to know that without the modern cylindrical grinding machine Shredded Wheat would be an impossibility. The manufacture of it was attempted without the cylindrical grinding machine, but it was not successful until taken up by the Brown & Sharpe Manufacturing Company who, by the aid of the modern cylindrical grinding machine, made Shredded Wheat possible. If, again, you call for Toasted Corn Flakes for your breakfast, remember that the modern cylindrical grinding machine is necessary in the production of those also. The same is true of the flaked rice and many similar cereals.

When your cook comments upon the beautiful pastry flour because it is smooth and velvety in its texture, you may know that the modern cylindrical grinding machine ground the rolls through which this flour passed. When you are undergoing the strain of the dentist's chair, you are again served by the grinding machine with the gold caps that form your modern crown work.

As you read your morning paper, your magazine, or your favorite author, you are being served by the modern cylindrical grinding machine that ground the rolls which rolled the paper, that ground the ink-rolls of the printing-press upon which they were printed.

And when we consider the satisfaction of our hunger and order a hamburger steak, we are still served by the grinding machine that ground the spiral cutter of the meat-grinder.

When we spread the butter on our bread, or eat our cream, we are served by the machine that ground the accurate parts of the high-speed cream separator. And after dinner when we sit down for a long winter evening, we are entertained by the music of the phonograph, the revolving parts of which are ground by the modern grinding machine.



When you glance at your watch and find that it is bedtime, remember that without the modern grinding machine to grind the rolls that rolled the main-spring and the hair-spring, and the material for the case, your watch could not be such an accurate yet inexpensive timepiece. And when you are awakened in the morning by the tones of the Canterbury Bells of your hall clock, remember that this silver-toned bell was rolled in rolls ground on a modern grinding machine.

The grinding machine serves us in much of our domestic life, and even Miladi's corset depends for success upon the flat rolled springs or stays that are rolled with rolls ground with the modern grinding machine.

The cotton from which very much of our clothing is made is compressed with hydraulic plungers which are ground on cylindrical grinding machines and the textile machine that prepares the cotton and wool for use depends upon the grinding machine for its success.

As you ride through the country and are charmed with its beauty, remember that the piston-rods, that are so rapidly reciprocating with each pulsation of the mighty engine that hastens you along, are ground with Norton grinding machines, and that Norton machines are made to grind the axles that revolve so rapidly, and that the smoothest running cars have wheels ground by the Norton car-wheel grinding machine.

When you take a trip to San Francisco to the great Exposition and sail through the Panama Canal, remember that the wheels for the safety-gates were ground in Worcester with a modern cylindrical grinding machine. If you ride to San Francisco overland, and cross the great agricultural country, you will see the modern powerful plowing, planting and reaping engines at work, and here the modern cylindrical grinding machine is serving the world when grinding great crank-shafts for these monster internal combustion engines.

When you ride in your automobile, it

may interest you to know that this now important factor in our world life has been made what it is by modern grinding machines. The present success would have been impossible without them.

The reaping machine, mowing machine, the engines that promote the labor of the farm, both for the house and the barn and the field, opening to the mother and father, daughter and son, a larger opportunity for study, pleasure and things that make life more worth living, until our farms now are fast becoming the objective point for young men seeking an education, we owe to the modern grinding machine.

There is hardly an industry that does not in some way depend for its business success upon modern cylindrical grinding machines. Calico printed with such beautiful figures, with which we are all familiar, is served by the cylindrical grinding machine in that it grinds the rolls through which the cloth is passed in the operations of printing; and the modern mercerized cotton, that so much resembles silk, depends upon the modern grinding machine for the preparation of those very artistically constructed rolls that so compress the fabric that it remains in this microscopic rib form to give the lustre that we admire so much in silk.

When we come to the iron working industries, the machine tool industry, locomotive building, ship building, cash register and adding machine, the typewriter, wood-working machine, printing machine and linotype so common now for the typesetting operations of our newspapers and magazines, the paper we use in correspondence, in fact almost every walk of life is served by the modern cylindrical grinding machine in one way or the other.

The modern cylindrical grinding machine, as made by the Norton Grinding Company, we trust will render the world more and more valuable service as the years go by. The first machine constructed by the Norton Grinding Company went into service at the works of the

R. Hoe Printing Company at New York and is still in service, helping to construct printing presses that print the papers and magazines which go to spread information

and general intelligence through the world. I, for one, feel very proud of this fact that our first machine went into such a broad and serviceable field.

Abstracts from Current Articles Pertaining to Grinding

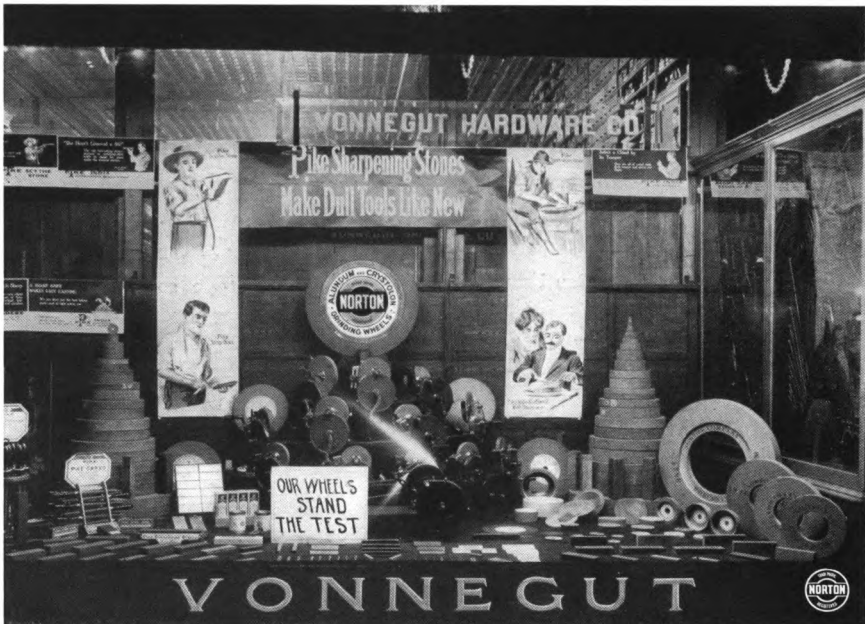
A recent product of the Lees-Bradner Co., Cleveland, Ohio, is a cutter grinding machine designed especially for sharpening hobs and radially relieved cutters. *American Machinist*, European edition, Dec. 6th, 1913, page 839; *Iron Age*, Dec. 11th, 1913, page 1337.

A new diamond holder, designed to absorb the shock and reduce the opportunity of cracking the diamond when dressing grinding wheels, has been put out by the Thomson Tool & Supply Co., Indianapolis, Ind. *American Machinist*, Dec. 18th, 1913, page 1051.

The Matson Machine Co., Concord, N. H., are making a new cutter and reamer sharpening machine designed for all types of milling tools up to 11" long and 8¾" in diameter. *American Machinist*, Dec. 18th, 1913, page 1051.

The latest addition to the line of grinding machines made by Forbes & Meyers, Worcester, Mass., is designed primarily for heavy work and is illustrated and described in *American Machinist*, Dec. 18th, page 1050.

An electric-driven grinding machine arranged for work 30 inches in diameter



Window Display at Vonnegut Hardware Co., Indianapolis, Ind.



Window Display at J. T. Wing & Co., Detroit, Mich.

and 20 feet long, a recent development of the Landis Tool Co., Waynesboro, Pa., is fully described in articles in the *Iron Trade Review*, Dec. 25th, 1913, pages 1147-1148; *Iron Age*, Dec. 25th, 1913, pages 1432-1433; *American Machinist*, Dec. 25th, 1913, pages 1092-1093.

In *American Machinist*, Jan. 1st, 1914,

pages 25-27, is an interesting description with good illustrations of four large German grinding machines built by J. E. Reinecker, Chemnitz-Gablenz, Germany. The first is a cylindrical grinding machine with a capacity of 10 m. (33 ft. nearly) between centers. The second is a view of another style of large cylindrical grind-



Dalren, Manchuria, Office of The F. W. Horne Co.,—Representing Norton Company and Norton Grinding Company

ing machine; the third is a view of a shell grinding machine and the fourth is a vertical surface grinding machine.

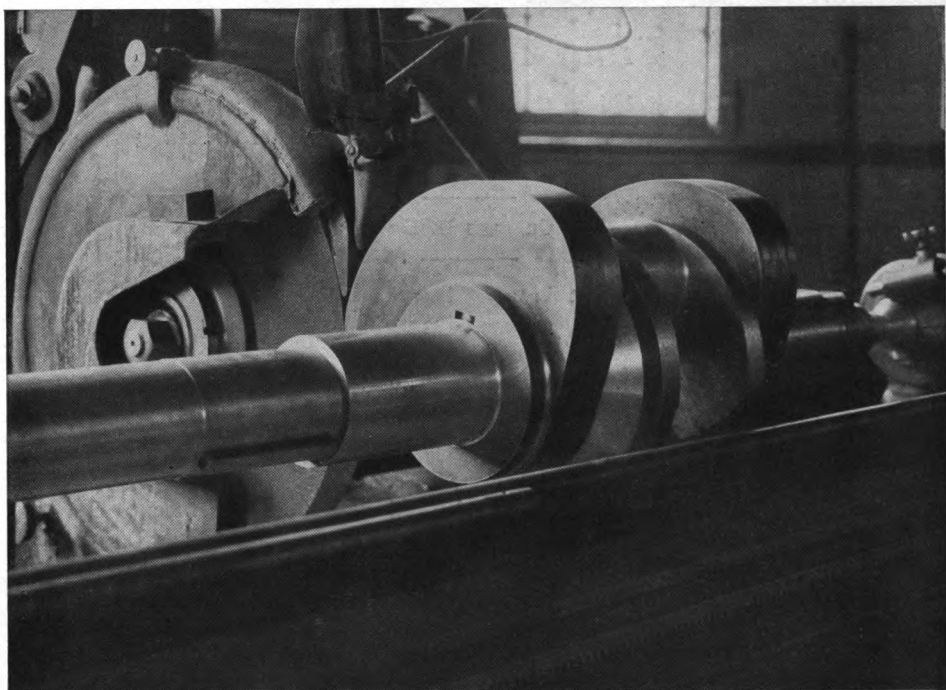
The Heald Machine Co., Worcester, Mass., has put out a 16" rotary type of surface grinding machine which is designed to combine accuracy with a high rate of production. *Machinery*, Jan. 1914, page 417.

[16]

A recent development by the Brown & Sharpe Mfg. Co., Providence, R. I., is a plain grinding machine equipped with various automatic features which make it essentially a manufacturing machine for grinding spindles, shafts, rolls, etc., either straight or taper, rapidly and accurately on dead centers. *American Machinist*, Jan. 8th, 1914, page 81.

[JAN. 1914]

GRITS and GRINDS



Grinding a Large Double-Throw Cam on a Norton 20' x 120' Plain Cylindrical Grinding Machine in the Plant of the Waterbury
Farrell Foundry & Machine Co.,
Waterbury, Conn.

FEBRUARY, 1914



GRITS and GRINDS

Vol. V

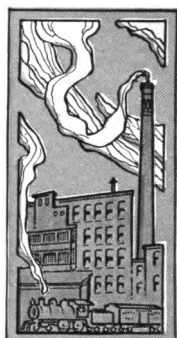
February, 1914

No. 10

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From the Cellar Up

An Address Delivered before the Boys' Vocational Club, Adams Square
Congregational Church, Worcester, Mass.—An Interesting
Human Document Full of Inspiration

BY CHARLES H. NORTON

When a small boy, not yet in my "teens," I sought and obtained employment in an old Connecticut "hame" factory. I had visions of wealth that I would gain from my industry, and entered the employ of an old-time contractor, who, among other things, did the polishing of the metal work on hames. He used wood wheels covered with leather and coated with glue and emery. A large part of my work was to "wash" or soak off the glue and emery from the worn wheels preparatory to the re-coating.

I wish it were possible to show a photograph of the place and the facilities—a low, dark cellar, among rats and mice, where never a ray of sunlight entered. A small leak in the old water-wheel flume furnished the water supply. I had to hold the wheels and so turn them that gradually the coating of glue and emery might soak away. It was a tedious and ambition-killing process for a boy—holding one wheel at a time and slowly turning it to bring all parts of the circumference under the stream. I remember that it required an entire day to wash a very few, and many days were required for the whole lot. I can recall

how injured were my feelings when I believed I was competent to perform the skillful mechanical work up in the shop above, and how I planned various protests, the language of which I readjusted from hour to hour that it might be convincing when the auspicious moment for its utterance should arrive.

At last the injustice of my treatment became so great in my mind, and the foolishness and wastefulness of such labor so plain to me, that the invention of a machine for doing the soaking automatically kept rising uppermost in my brain, until I forgot my eloquent protest and fell to studying out the great invention. I forgot all about the darkness and loneliness of my workshop. I forgot all about the fact that I was slowly turning in my hands the wheel that was soaking. I forgot that my clothes were wet. I forgot that I was cold from the water that missed the wheel. I forgot that it soaked me. All this was forgotten in the mental visions of the machine that was to wash a dozen or more wheels in the same time I was washing one, and was to do this while I was employed at more useful and more interesting work above.



At last, when my vision was complete, full of hope and visions of progress, I summoned up my courage to explain it all to my employer. Alas! I did not know that I was then to learn my first lesson in opposition to progress. My employer laughed, and several others with him. The impossibility of washing a dozen wheels at once and without labor was too clear to them to admit of a doubt. Little did I realize then that this opposition was only the beginning of what my life should encounter in the introduction of new designs and processes. Little did I then understand that all progress must be made in the face of opposition from those who, it would be natural to suppose, would be more interested in it.

I then also learned my first lesson in false economics. I was informed that if such a machine could be made to work, I would be out of a job. I replied that I could be employed at some of the work in the shop more interesting. I was informed that there would then be no work for others. They were too much for me then, but I could not get over the belief that, with the washing machine in operation, I could be more profitable and my work more interesting. I was crestfallen. My invention was turned down by my employer. I was laughed at.

I stole away quietly and waded in the pool under the water wheel that was then still for the noon hour.

There were some bright, shining fish darting about, and it was easy to catch them with the hands as the stopping of the wheel had locked them in the pool owing to the lowering of the water connecting with the outer stream. My grief was somewhat healed by the easy catch of fish to carry home at night to my mother, and I pictured her interest in my possession when I should hold my string of fish proudly out as I came in.

My mother! It was she who never laughed at my inventions and plans, but who assisted me to build water wheels and engines of shingles and tin spice boxes; who did not scold me when grand-

mother's sacred "skunk's oil" was missed because I had used it to oil my lathe in the barn. To her I unfolded my plans for a wheel-washer and told her of the attitude of my employer toward my invention. It was she who encouraged me to keep on with my study. It was she who assured me that sometime not far distant I would see my invention realized.

Time and change have wrought their wonders since then. "The old hame shop" is gone. A fire destroyed it years after, and the place where I worked, alone in the darkness, is now uncovered to the sunlight and the wild flowers bloom there. My mother has gone, leaving the bright memories of her kindly life and helpfulness.

Fifty years have passed since then, but her assurance that some day my washing machine would be a reality has proved true. To-day there are in use many of these machines, and no boys are washing buffing wheels by hand.

In view of this, the facts I would impress upon young men, are:

First: That while the first struggles determine it afar off, final success in life comes not at the beginning of life, when one is young, but only after years of hard, patient work.

Second: To succeed as a leader and creator of useful things, that help the world to a higher and better life, whether it be the designing and invention of machinery, methods, ideas or changes in any form, one must always encounter the opposition of both high and low, the educated and the ignorant.

Third: The greatest reward comes by the way of one's own inner consciousness of having accomplished something to help the very world that has opposed him. For it is true that few men who really create the ideas and improvements that make the world better receive frank recognition from those that their efforts have helped most.

The poet Byron expresses this experience most forcibly thus:



"He who ascends to mountain tops
shall find
The loftiest peaks most wrapped in
clouds and snow;
He who surpasses or subdues man-
kind,
Must look down on the hate of those
below;
Though high above the sun of glory
glow,
And far beneath the earth and ocean
spread,
Round him are icy rocks, and loudly
blow
Contending tempests on his naked
head,
And thus reward the toils which to
those summits led."

While this is ever the lot of creators
and producers of new and better things,
yet finally the creator and producer who
is really a leader in his line usually is
better paid in this world's goods in pro-
portion to his efforts than the one who
chooses the more cleanly, non-creative
and non-productive and so-called "cul-
tured" pursuits.

But after all what is more satisfying
when old age comes than to realize that
you have, by your efforts, created and
produced those things by which the world
is fed, clothed, and educated? Even
though when young, to get your train-
ing you had to work, work, work; and
to wash off dirt, dirt, dirt; and perhaps
you had to see yourself despised by *that*
Girl and her mother, who preferred a
young man who always wore clean
cuffs and had manicured finger nails.

The world needs its scholars, its preach-
ers, its bankers, its merchants. Cleanli-
ness is also a great necessity and a virtue.
But the world would have little need for
all these, if it were not for the creators
and producers who earn the money to
meet the needs of all classes. So with
due respect for all the many workers in
the many phases of human endeavor I
think we can all say heartily:—

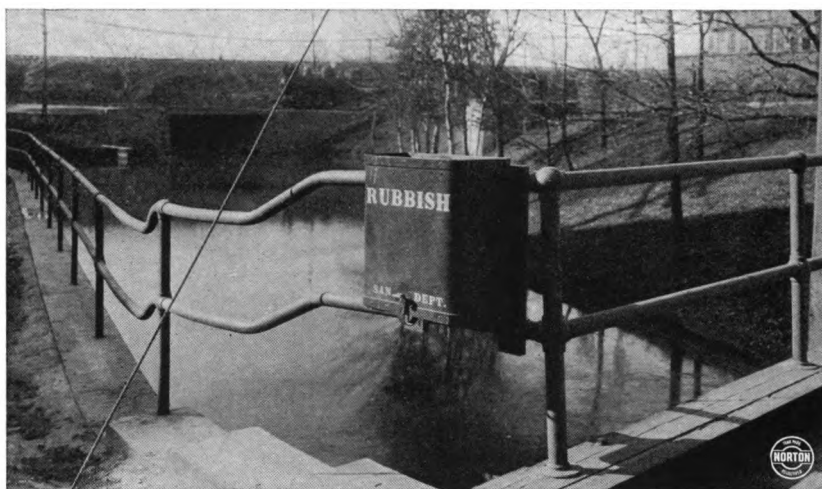
"Here's to the man who plans things

—Builds things—makes things.

Who prates not of wonders old,

Nor gloats upon ancestral gold,

But takes off his coat, and takes a hold
And does things."



Quality of Product Requires Cleanliness in the Plant and its Environment. This
Illustration Shows How Norton Health and Sanitation Department are
Providing Means to Keep the Norton Grounds Clean



TABLE OF CAUSES OF GRINDING-WHEEL ACCIDENTS

Broken wheels (caused by)	Improper inspection of wheel	{ Before issued to operator. When being mounted.
	Dropping or striking against some object while not being operated.	{ Carelessness. While being mounted While standing
Cracked wheel (caused by)	Being forced on improper sized spindle	{ Too small bushing. Too large spindle.
	Heated Spindle	{ Tight bearings
Too high rim speed (caused by)	Only one flange	{ Inner flange not fixed on spindle. Careless mounting. Ignorance.
	Uneven bearing of flanges	{ Bent or broken flange or flanges Bushings projecting beyond sides of wheels
Broken wheels (caused by)	Flanges of different diameters	{ Improper specifications. Ignorance. High spots on flanges
	Flanges not properly relieved	{ Entirely without relief
Broken wheels (caused by)	Compressible washers	{ Diameter of relief too small
	Tightening of nut	{ Missing
Broken wheels (caused by)	Hacking of wheel	{ Too thin
	Screwing wheel on taper arbor	{ Too small diameter. Carelessness. Ignorance of mounter. Desire for increased cutting. No restriction on use of wheel. Ignorance.
Broken wheels (caused by)	Spindle overspeeded	{ Overspeed when first set up. Desire for increased cutting. Speed increased ..
	Use of too large wheel for spindle speed	{ Thoughtlessly increasing speed of line shaft. Desire for increased cutting. Use of cone pulley ..
Broken wheels (caused by)	Use of too large wheel for spindle speed	{ Shifting to small pulley. Loose shifter. Carelessness.
	Use of too large wheel for spindle speed	{ Wheel initially too large Too large wheel substituted Wheel of different grain and lower recommended speed substituted. Wheel of different shape substituted. Wet wheel substituted.



GRITS and GRINDS



Catching work between rest and wheel (caused by)	{ Improper adjustment of rest. { Lack of attention. { Ignorance. { Improper handling of work { Side grinding when rest not designed for it. { Pushing work under rest { Ignorance. { Loose bearings { Lack of attention. { Ignorance. { Bent spindle { Lack of attention. { Ignorance. { Loose frame { Lack of attention. { Ignorance. { Rough or improper use { Inexperienced men. { Responsibility of foreman. { Wheel standing in water (see under "cracked wheel"). { Side grinding (see below). { Wheel untrue. { Wheel standing in water (see above). { Side grinding (see below). { Hacking wheel (see above). { Bushing too small in wheel { Ignorance or indifference. { Wrong spin. used for size of wheel { Ignorance or indifference. { Lack of proper equipment. { Inexperience of men. { Indifference. { Spindle threaded in wrong direction { Improper specifications. { Belt twisted so that machine runs opposite to initial direction { Equipment incorrectly erected. { Motor reversed { Ignorance. { Spindle turned end for end { Ignorance. { Caught between rest and wheel. { See above.	
Out of true (caused by)	{ Entire lack of exhauster { Exhauster not provided. { Exhauster disconnected. { Exhauster line not proper size { Desire for saving expense. { Exhauster line stopped up { Not often cleaned. { No goggles provided. { Poorly designed or constructed. { Improper goggles provided. { Prejudice. { Goggles not used { Carelessness. { Fear of infection.	
Unbalanced wheel (caused by)	{ No chip guard. { Chip guard not in use { Broken and not replaced. { Chip guard defective (caused by)	
Weakened wheel (caused by)	{ No guard for dresser. { Flying pieces of broken revolving type of dresser (caused by)	
Too small spindle (caused by)		
Side grinding on improper wheel (caused by)		
Mounted so that nut works loose (caused by)		
Caught between rest and wheel.		
Exhauster defective (caused by)		
Eye protection insufficient (caused by)		
Chip guard defective (caused by)		
Flying wheel unbroken (caused by)		
Work or dresser hurtled out of workman's hand (caused by)		
Flying particles of emery, inhaled or in eye (caused by)		
Flying pieces of broken revolving type of dresser (caused by)		

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Prepared by the Independence Inspection Bureau of Philadelphia for General Distribution.



test immediately before they are shipped, whereas it is only too frequently evident that the user has jumped to a conclusion that a wheel must have been defective or else it could not have broken.

In a great majority of cases, the one who handles the correspondence relative to wheel breakage is the purchasing agent or one of his assistants. Due to the fact that his work does not take him out into the factory, he necessarily uses statements furnished him from the factory as the evidence for his presentation of the subject. When the reply from the wheel

manufacturer is received, it is quite likely to end with the request that a careful investigation be made of this particular breakage with the object in view of determining whether or not all the rules for the proper operation of a grinding wheel have been complied with.

There are shown herewith two views which are self-explanatory as to the interesting precautions which the manufacturer uses to make sure that every wheel shipped is properly tested to a high factor of safety.

Notes on Use of Elastic and Vulcanite Wheels

By C. E. GILLET

The first abrasive wheels were natural stones. The use of these natural stone wheels was limited very largely through the fact that they did not have the physical properties requisite for efficient use on metals, and through want of proper machines and methods of application. The use of an abrasive wheel for grinding metals has always been taken as a fundamentally correct idea and efforts toward the success of this idea are seen first in the hydraulic cement wheels which were made in imitation of the natural stones. These failing even with the hardest of abrasive grains, the second step was the use of organic substances which melt when heated and are hard when cold. The shellac, rosin, sulphur and rubber bonded wheels were tried. Wheels bonded with shellac and with rubber were successful to a considerable degree and have a special field of usefulness to-day.

Following the organic bonded abrasive wheels there came the silicate of soda and the vitrified or (more correctly speaking) the completely fused clay bonded wheels both of which rapidly gained favor.

To-day the metal trades have not only a variety of wheels from which to make

selection, but also have highly efficient machines. The development of the grinding machines to their present day efficiency has played no small part in the history of the several kinds of grinding wheels, and finally in the definiteness of the fields to which each kind is adapted.

To write exhaustively on the fields of use for each of the kinds of wheels now made would require much more space than is available in Grits and Grinds. Even a complete exposition of the Elastic and Vulcanite fields cannot be had. The present note therefore is confined to the defining of the most important fields and this only in general terms for the Elastic and Vulcanite abrasive wheels.

As the trade recognized the freer and cooler cutting qualities of vitrified wheels on practically all grinding operations in the iron and steel industries, the elastic and vulcanite wheels were slowly but surely superseded. They were not and probably will not be eliminated altogether, since there is a field wherein their particular properties make them peculiarly efficient and where a vitrified wheel can never successfully compete.

Method of Manufacture

The elastic bonds are composed of shellac and other gums which completely fill the voids of the wheel. The vulcanite bonds are composed of rubber as the name implies.

Elastic and Vulcanite wheels are made by a pressing or rolling operation, and have a very dense structure, the abrasive grains being imbedded in the bonding material. This does not permit of as fast grinding as is possible in wheels of a porous structure containing a considerable number of clearance spaces or voids.

Some manufacturers cover the sides of their cutting off wheels with a coating of fine abrasive grit or sand, to give the appearance of a good close uniform wheel structure. This coating comes off while making the first cut, in fact it can be scratched away with a chip of wood and is of no practical use. However, on thicker wheels this coating on the sides of the wheel is used as a means of bringing the wheels into balance. This practice is not to be recommended, because the varying thickness of the wheel will cause it to run out of truth on the sides.

Clearance in Wheels

The effect of clearance in these wheels has come up at various times. The idea being that such a wheel would prove to be much faster cutting. Therefore the Norton Company had a wheel made up which looked like the bottom of a collendar, being filled with small holes. This wheel was tested by the Mechanical Laboratory, where it was found to cut fast and with a small wheel wear, working as smooth as a regular wheel. It was felt that, while these holes allowed room for the chips to be carried away, making a more free and uniform cutting wheel, that as much good was received by the cooling effect. That is, the clearance spaces or holes allowed a circulation of the air through the wheel which kept the wheel cool, preventing the bond from softening and also prevented knocking taking place. However,

if the proper grain and grade of wheel and the correct wheel speeds have been selected there is no decided advantage in using a clearance wheel of this type.

The elastic bond has a limited range of grades, a high tensile strength and considerable elasticity. The vulcanite or rubber bond has the general characteristics of the elastic bond, but its grade, or degree of hardness, cannot be varied as extensively and therefore its uses are more limited. Advantage is taken of this property of Elasticity to make very thin wheels.

Elastic and Vulcanite wheels are made as thin as 1-32" thick up to 4" diam, 1-16" thick up to 8" diam., and 3-32" thick up to 12" diam. Wheels of very fine grit and small diameter have been made as thin as 1-64". Solid, Elastic wheels are being made commercially as large as 26 inches diameter, and 2 inches thick, while vulcanite wheels are being made 16" diameter and 2 inches thick.

Uses for Each

The thin wheels are used for slotting and cutting off stock. Tubing, pipes, wire, thin sheets of steel or brass, in fact most materials which are difficult to hold for cutting by regular tools are cut off very easily and efficiently by these wheels.

The thicker wheels are used for saw gumming, grinding between the teeth of gears, sharpening moulding cutters, wood working tools, etc. They are also used for cutlery work, and roll grinding where a very smooth polished surface is desired.

Condition of Use

Elastic and vulcanite wheels can be safely run in water. Elastic wheels should not be used in oil or caustic soda. The oil will soften the bonding material, and the wheel will quickly wear down, while caustic soda will disintegrate the wheel structure. This does not hold with vulcanite wheels as they can be run in both these lubricants, without injury to, or the disintegration of the bond and abrasive.



For cutting off work, a wheel speed of 9,000 to 11,000 surface feet per minute has been found most efficient. For most operations, outside of cutting off, a wheel speed of 5,000 to 6,000 surface feet per minute is recommended.

Cutting off wheels will do work which no edged cutting off tool or saw can do, that is cut-off unannealed high speed steel lathe tools with the minimum amount of waste.

A few words concerning the machines upon which these wheels are mounted may not be out of order. The machines are very simple, having merely a support for the wheel and another for the piece to be cut off.

For cutting-off small, light pieces, the wheel is stationary and the work carried to it, while on long, unwieldy pieces the work is kept stationary and the wheel brought to it.

These machines will cut off steel, iron, brass, bronze, copper, nickel tubing or pipe, or any other metal up to 3" diameter. They will also cut off pieces of any shape and practically any material to 2" diameter. One manufacturer of these machines states that "more solid stock, not over 1 1/4" diameter, can be cut off in one hour than can be cut with a power hack saw in 15 hours." "The machines can cut off a tube or pipe in less time than it takes to set the tools to do it any other way, and besides it cuts off the work perfectly square and does not reduce the area of the pipe by raising a large burr on the inside of it. In fact this machine is to metal workers what the band saw is to the carpenter."

Performances

One-inch diameter and one-half inch diameter wrought iron piping is cut off in 11 to 12 seconds and 6 to 7 seconds respectively by a 30 grade 8 Alundum vulcanite wheel.

In cutting through bars of machinery, steel 1 1/2" x 1/2" cross-section a 20 grade 3 Alundum Elastic wheel, cut at the rate of 4.70" per minute while a vulcanite

wheel made of alundum 30 grade 8 only passed through 3.31" of the same bar per minute. The elastic wheel wore slightly more, but did not burn the bar as did the Vulcanite wheel. The softer metals are cut off much quicker than the hardened and alloy steels.

To show the difference in speed of cutting metals, a test was made on a bar of gray cast iron and a bar of machinery steel of 1 1/2" x 1/2" cross-section under the same pressure. A 30 grade, 8 Alundum Vulcanite wheel cut through the machinery steel bar in twenty-five seconds while it cut through the cast iron bar in eighteen seconds.

An illustration of the efficiency of modern abrasives over emery is found in the following. Two wheels, one of emery, and one of alundum were made to the same grain combination and grade. When tried on the same bar of steel under identical conditions, the alundum wheel cut through 3.62 inches and the emery wheel through 2.50" of metal per minute, which shows 45% faster cutting ability and with less wear for the alundum wheel. However as a general rule, elastic wheels cut approximately one-third faster, but wear three times more than vulcanite wheels.

Sometimes trouble is encountered by the wheels crumbling. This may be due to either of three causes, the first being excessive heat which softens the bond. This may be eliminated by varying the pressure under which the work is applied to the wheel, using a softer wheel or by a combination of both. Second, too low a wheel speed will cause the wheel to act softer and crumble under heavy pressure. Third, too coarse a sized grit for the operation in question, for which anyone would naturally substitute a finer wheel.

These wheels are in a way self-truing, and therefore give little trouble on this account. However, the more and the oftener the wheels get out of truth and knock against the material being ground, the faster they will cut through the material, but with resulting greater wheel wear.

For general purpose cutting off wheels, where the speed of cutting is not a large factor, vulcanite seems to be the better wheel. However, for cutting off tempered tool steel or alloy steel tools, where cool cutting is the main consideration, then the elastic wheels can undoubtedly be used to better advantage on account of their softer grades and resulting cooler grinding action.

While elastic and vulcanite wheels are being used somewhat on operations out-

side of slotting, grooving, nicking and cutting off, they are slowly but surely being superseded by wheels manufactured by the vitrified process. The more porous structure of the latter wheels allows of a much freer and cooler grinding action, with a proportionate increased production, and in these days of high efficiency increased production is the keystone of success. However for slotting work, where a thin wheel is required, it will be impossible to replace wheels made by the elastic and vulcanite processes.

Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

A method employed to produce an accurate bore for indexing wheels of the Fellows Gear Shaper forms the subject of an article by E. Stubbs, in *American Machinist*, Dec. 18th, 1913, page 1043.

The Selson Engineering Co., Ltd., London, E. C. England, are introducing an improved tool and drill grinding machine which is shown and described at some length in European edition of *American Machinist*, Nov. 8th, 1913, page 93e.

Two new direct-connected motor-driven grinding machines have been placed on the market by the Gardner Machine Co., Beloit, Wis. The first machine is designed for use in ordinary pattern-making shops, while the other is chiefly for experimental laboratories and for shops where special machines are built. *Iron Age*, Jan. 8th, 1914, page 114.

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has brought out a planer-type, surface grinding machine for handling such work as armor plate, locomotive, radius links, etc. *American Machinist*, Jan. 22nd, 1914, pages 175-176.

Special grinding operations on mono-type work are illustrated and described

in an article by Fred H. Colvin, in *American Machinist*, Jan. 22nd, 1914, pages 133-136.

A new adjustable protection hood has been added to the line of grinding machines manufactured by The Valley City Machine Works, Grand Rapids, Mich. The guard is made in sizes to accommodate wheels ranging from 8 to 24 inches in diameter, and can be applied to any make of grinding wheel stand. *Iron Age*, Jan. 29th, 1914, page 320; *Machinery*, Feb. 1914, page 522.

A cutter and reamer grinding machine has been developed by the Bath Grinder Co., Fitchburg, Mass., which, while it resembles their line of universal grinders, embodies several distinctive features. The machine has a capacity for inserted-tooth, milling cutters up to 20 inches diameter. *American Machinist*, Feb. 5th, 1914, page 259; *Machinery*, Feb. 1914, pages 514-515.

A new multiple-pole, magnetic chuck with a capacity for a wide range of diameters is a new product of O. S. Walker & Co., Worcester, Mass. *American Machinist*, Feb. 5th, 1914, page 261.



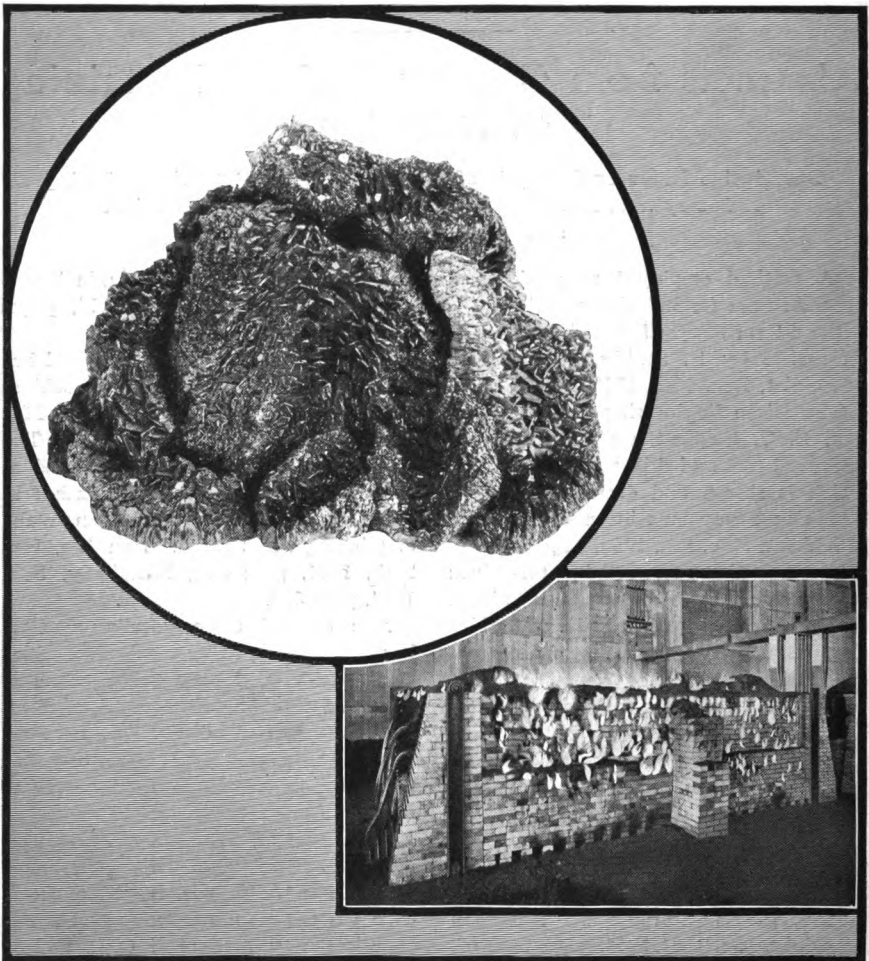
Special machines—one for grinding valves of engines, pumps and compressors; another for grinding large milling cutters; another special machine for grinding manganese steel crusher mantle—are some of the special features illustrated and described in an article, "Progress in Design and Use of Machine Tools," appearing in *Iron Trade Review*, Feb. 5th, 1914, pages 283-290.

The Modern Tool Co., Erie, Pa., has brought out a small, plain grinding machine

designed for manufacturing purposes. It is especially adapted for small, straight or taper, cylindrical grinding. *Iron Age*, Feb. 12th, 1914, page 443.

A new floor type grinding wheel stand is a recent addition to the line made by the Royersford Foundry & Machine Co., Royersford, Pa. *American Machinist*, Feb. 19th, 1914, page 350.

A fixture for truing grinding wheels is described by Charles E. Alarie in *American Machinist*, Feb. 19th, 1914, page 336.



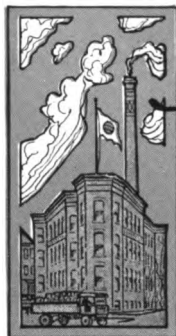
Crystolon and the Crystolon Electric Furnace

GRITS and GRINDS



**Group of Apprentices Taking Norton Grinding Co. Courses in
Norton Educational Department.**

MARCH, 1914



Grits and Grinds

Vol. V

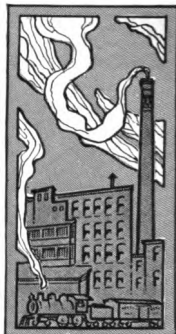
March, 1914

No. 11

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Norton Educational Department

**An Apprentice School with Several Courses Designed to Fit Young Men to
Become a part of the Organizations of Norton Company and Norton
Grinding Company. A Carefully Planned Expansion of
Former Apprentice Courses, Drawn in Part from
the Experience of Other Members of
the National Association of
Corporation Schools**

For some time Norton Company has conducted a course of instruction to train men for its sales force. To broaden the scope of the work, and train young men to occupy positions in all departments, not only of Norton Company but also of Norton Grinding Company, the officials of the two companies have recently organized an Educational Department.

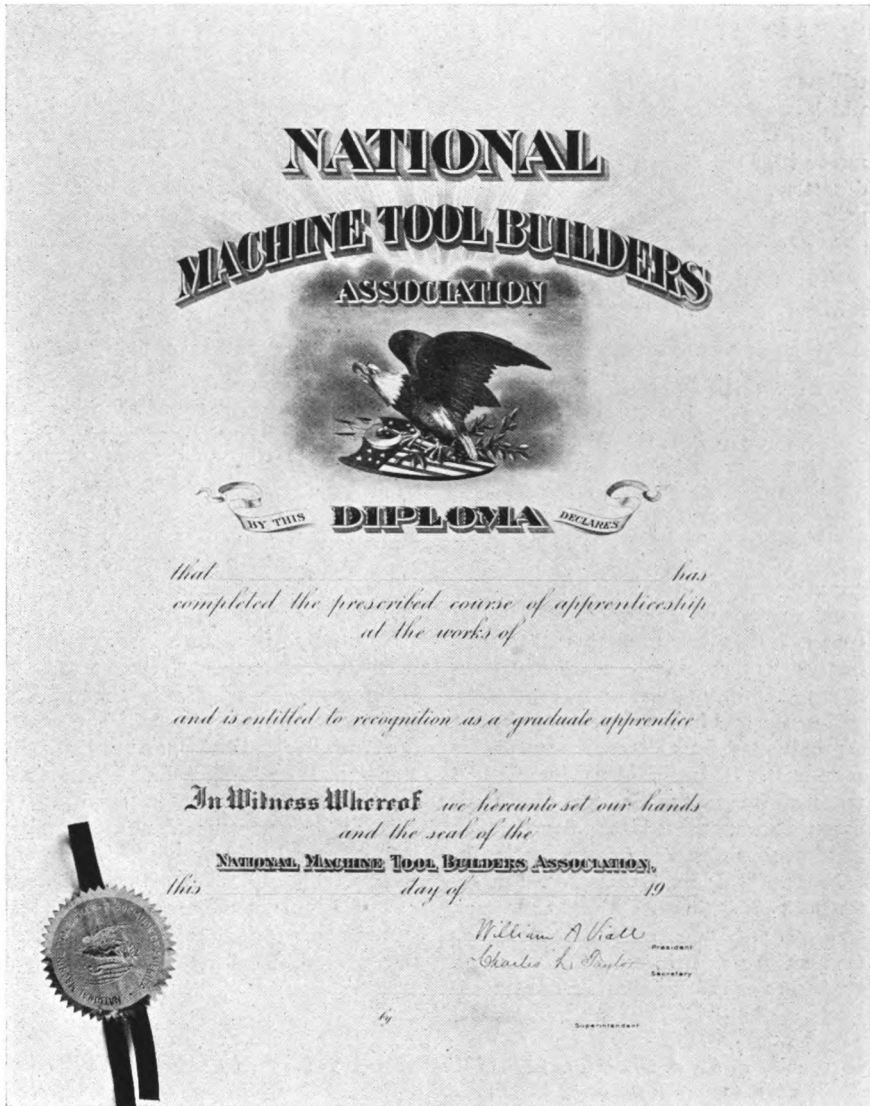
Students in all courses are under the direct care of the Supervisor of the Department. It is his duty to see that the students receive the necessary practical experience to fit them for positions which the courses of instruction are designed to qualify them to fill. He will also arrange for whatever lectures and recitations may be thought desirable to give them essential theoretical training which will be directly applicable to the manufacture of grinding wheels or machines, or the art of grinding.

Norton Company course No. 2 is intended primarily to prepare men for positions in the sales organization. If the student, after successfully completing his course, does not possess the necessary natural qualifications for this line of work,

he will be finally assigned to the Laboratories, the Engineering, or other technical departments of either company. The requirements for admission to this course are high, and the length of the course will be approximately two years. During this time, the student will be given regular work in all important departments of the Norton Company plant, and in several of the more important departments in that of the Norton Grinding Company. It is believed that only by actively performing the work in the shop will a thorough knowledge of the business be obtained.

The classroom work will include lectures on the technical work in connection with the manufacture of Norton products, on efficiency, and on the art of grinding in general. Students will be required to keep complete notes on lectures and to write weekly reports of practical work done in the shop, and will be graded on these, on such examinations as may be necessary, and on the general quality of work done in the shop.

Norton Company course No. 3 is intended to prepare young men for clerical



Diploma of National Machine Tool Builders Association

positions in the shops or offices of either company. The length of this course will be approximately six months, during which period the student will be given such practical work in the shop as may be necessary to enable him to become famil-

iar with all Norton products and in a general way with the processes employed in their manufacture.

It is not expected that he will become acquainted to any great extent with the technical work involved in manufacture,



but that he will understand more or less thoroughly the technical and shop terms so that he may be able to carry on in an intelligent manner the clerical work to which he is finally assigned.

The lectures in this course will deal more with the routine work of the various departments of the organization, company policy, etc., rather than with technical questions.

Norton Company course No. 5 is intended to give outside shop men who have had experience in rough grinding and snagging, or men from our own shop, an opportunity to learn more about grinding wheels, the proper methods of using them, and the methods for properly determining the size, grain, grade and kind of wheel for any particular class of work.

This will afford an opportunity to other companies, who are engaged in snagging heavy iron and steel castings, grinding switch frogs or other similar rough work, to assign a young man to this course for such training, under such arrangement as may be mutually agreeable to the parties concerned.

The length of this course will depend somewhat on the past experience of the men taking it. For a man who has had thorough experience in practical work before entering upon his studies, the time required should be from four to six months.

Norton Grinding Course No. 1 is intended to fit young men for journeyman machinists and to give them the necessary training in elementary mathematics and mechanics as well as considerable knowl-

edge of the composition and strength of various metals used in machine construction so that they will better understand the problems of their trade.

The length of this course will be three years and after successfully completing the course the student will be awarded a diploma of the National Machine Tool Builders' Association of which the Norton Grinding Company is a member. This diploma will be honored in the shops of all members of the Association, of which there are approximately 200, and no doubt in the shops of a great many non-members.

Norton Grinding Course No. 2 is intended to prepare men to serve as expert demonstrators for the Norton Grinding Company or to act as expert grinding machine operators for other concerns. In this latter phase the course is similar to Norton Company Course No. 5, but is intended particularly to fit men for the art of machine grinding instead of the work of rough grinding as in that case.

To be admitted to this course a candidate must give satisfactory evidence that he is a journeyman machinist or that he has natural mechanical aptitude. The length of this course will be approximately eighteen months and will include both practical work and theoretical instruction.

The tremendous growth of the grinding field offers splendid openings to the well-trained man and it is hoped that the work of this Educational Department may result in placing in the grinding field young men who will be active factors in the further development of the art of grinding.

Two Questions and Their Answers

BY H. N. HARDING

QUESTION 1.

In what respects is the action of a grinding wheel different on a plane surface from what it is on a comparatively small cylindrical surface?

The point of contact between the wheel and the work, with a given diameter of

wheel and depth of cut is longer in the case of the plane surface.

In grinding a cylindrical surface two inches in diameter the contact between the wheel and the work is only one-quarter as large as that between a flat surface and wheel, wheel diameter and depth of cut being the same.



QUESTION 2.

With the periphery speed of the grinding wheel constant what combination of the remaining elements would you suggest?

- (1) for rapid production?
- (2) for high finish?

(1) Rapid Production.

(a) Surface speed of work should be such that the bond will be worn away sufficiently to allow clearance for the particles of work removed.

(b) Depth of cut. As much as possible and have clearance for the work particles.

(c) Table traverse. Should be sufficient per revolution of the work so that all parts of the face of the wheel do an equal amount of work, i. e. should be approxi-

mately the width of the wheel per revolution of the work.

(d) Wheel. Should be trued coarse but this is most necessary when the wheel is not the proper one for the work.

(2) High Finish.

(a) Slow surface speed of work. Less work will be done by the particles of the bond; therefore, the bond will not wear as much and the clearance of the wheel particles will be smaller.

(b) Smaller depth of cut as clearance is small.

(c) Slow table traverse. Generally used to increase the polishing effect, but not absolutely necessary.

(d) Wheel trued on slowest table traverse. Wheel must be a perfect cylinder to produce a high finish.

Speed Charts

BY CARL F. DIETZ

In properly selecting a grinding wheel for any specific purpose much data is necessary. The factors which are as important as any, and perhaps more so, are speed of wheel and speed of work, when cylindrical grinding is in question. By the term "speed," reference is made primarily to surface speed, that is, the speed at which the periphery, either of the wheel or work, travels per unit of time, usually per minute.

For any given wheel an increase of speed tends to make the wheel act harder, and in the case of cylindrical grinding relatively high work speed requires a wheel of greater resistance than if the work speed is low.

Surface speed of either wheel or work can, of course, be readily calculated by knowing the number of turns per minute made, together with the diameter. For the rapid determination of these factors such devices as speed calculators, slide rules and tables have been prepared; how-

ever, in each case requiring certain manipulations, leaving something to be desired in the way of simplicity.

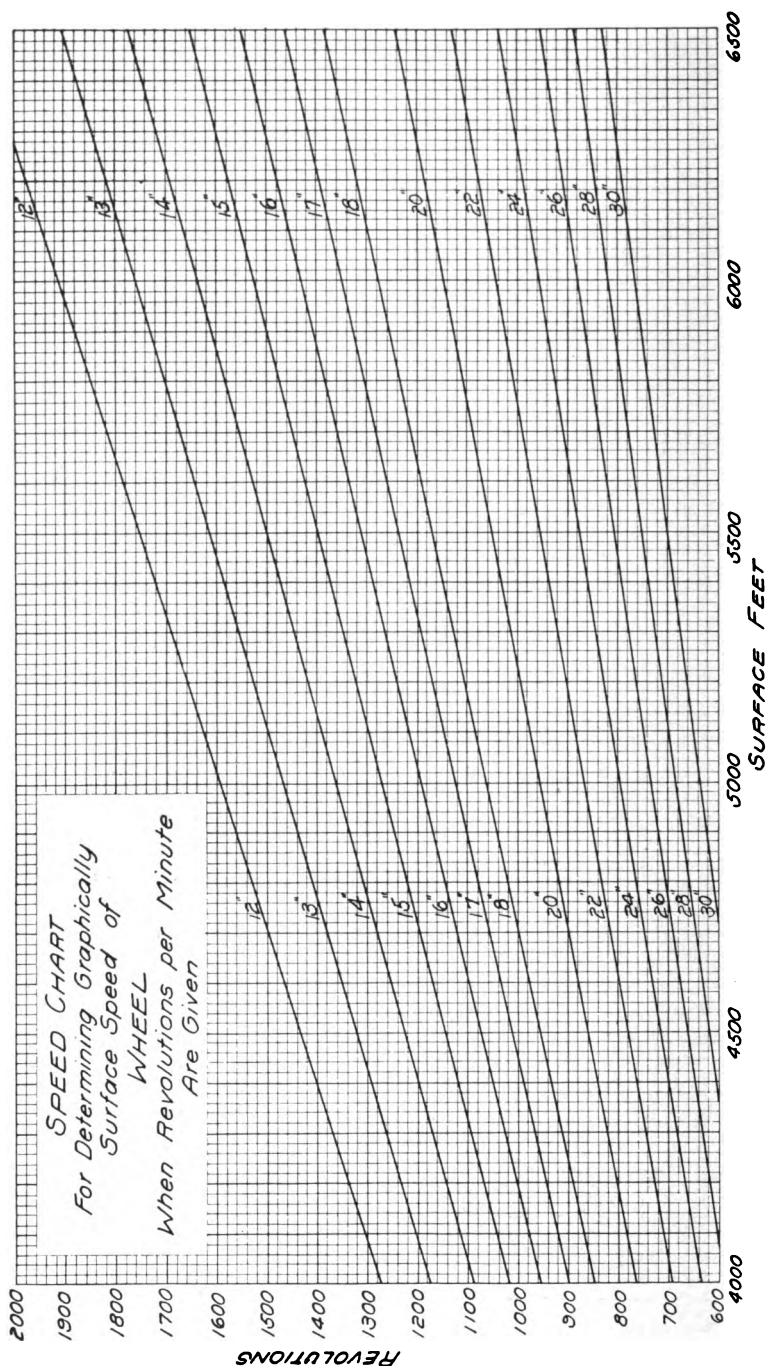
Speed charts, as shown herewith, may be advantageously employed, one for the greater range of diameters of wheels and their higher speeds and one for the lesser diameters and lower speeds of the work. The straight line across the chart for any one given diameter will, where it intersects the cross-sectional lines of the chart, immediately establish the number of feet per minute traveled by any point on its surface, for any given number of revolutions and vice versa. Any intermediate diameters or speeds may readily be interpolated between those recorded.

The purpose of these charts is to provide facilities for rapidly translating one factor into terms of the other, and the charts are so prepared as to cover everyday grinding practice.

We will be glad to supply these to anyone interested.

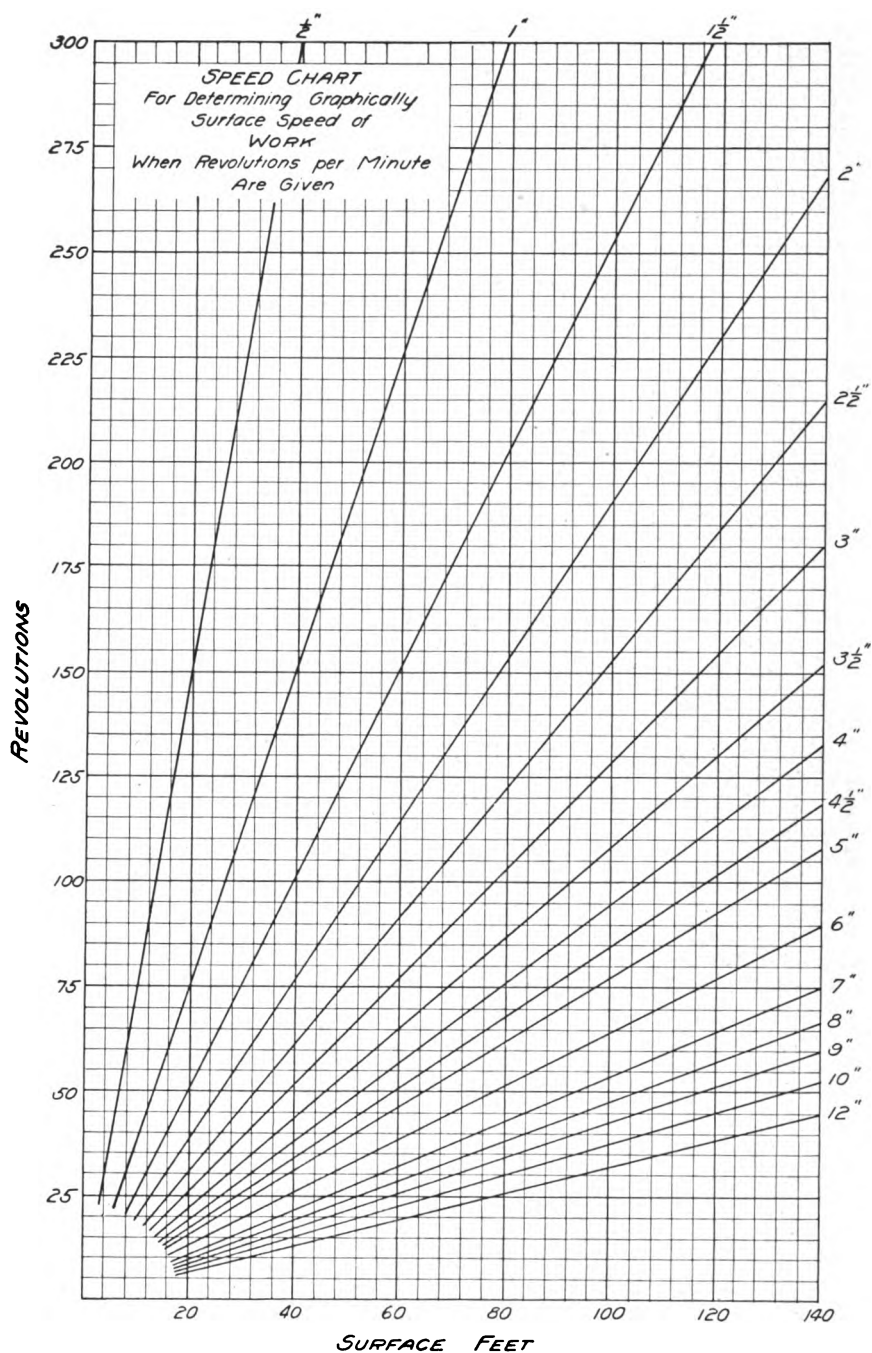


GRITS and GRINDS





GRITS and GRINDS





Why Do Grinding Wheels "Fill" or "Glaze"?

By OSCAR A. KNIGHT

I have found with cylindrical grinding that wheels sometimes fill and then glaze. I have also found that wheels sometimes glaze without filling.

Filling of a wheel, commonly called loading, is when small chips adhere to its face. When this condition exists, the clearance places between the cutting particles become filled and prevent the wheel from cutting freely. When a wheel becomes partly filled, and the operator continues to use it in this condition, the few remaining uncovered cutting particles glaze, and he believes the wheel is too hard.

It has been my experience that filling takes place only with soft and tough material such as brass, bronze and steel, both soft and heat treated. I can recall no difficulty from filling with hardened steel or cast iron.

Filling may be caused by the wheel running at a speed either very much or a very little too slow. Speed should be from 6,000 to 6,500 surface feet per minute. Filling may also be caused by crowding a hard wheel to a greater depth of cut than the size of the projecting grains, and revolving at a slow speed with plenty of power the grains would withstand this crowding without breaking away, and thus "pick-up" as the operators say.

There is one plant where there are eight 6 x 32" machines in one department in line with each other. The "Safety First" superintendent obliged the foreman to reduce the wheel speed. The speed of a 14" diameter wheel on a 6 x 32" Norton machine should be 1,760 r. p. m. The Safety Superintendent dropped this speed to 1,450 r. p. m. A week later I called, and the foreman asked why he could not finish with the eight machines as he once did. He said he could grind only twenty pieces between truing. With

a speed indicator I found his wheel was running about 5,250 periphery feet per minute. We found the old pulleys and brought up the wheel speed. His operator then ground four hundred pieces between truing.

In connection with this subject I will report the action of a wheel which was used in an automobile factory this last month. A 10" x 50" Norton Plain Machine, equipped with a 20" x 5 1/4" x 12", 38, 24 L wheel, grinding vanadium steel shafts 1" diameter, removing .035" to limit of .001". The shafts were 53" long and only their ends were ground 5 1-8" long. One hundred and eighty-six of these ends were ground in four hours. This time included truing the wheel twice throughout the four hours. One truing lasts for one hundred pieces. The total wear of wheel on one hundred and eighty-six shafts was .020" on diameter. There is 4 1/4" of wear on each wheel. This means that approximately 40,000 pieces can be ground with one wheel. There was absolutely no filling or glazing, and very little wear to this wheel. These shafts were inspected by the inspector foreman and pronounced the best work he had seen since he took charge of this department.

Glazing is when the cutting particles of a wheel have become dulled or worn down even with the bond, the bond being so hard as not to have worn away between the cutting particles to give clearance, and thus preventing the cutting particles, when dulled, from breaking away, and allowing new particles to do the work. Glazing is caused by too hard a wheel or too fast a speed or both.

Glazed wheels caused by a hard bond result in spindle boxes wearing out of true and out of line, excessive wear of workshoes, mottles, chatter marks, feed



lines, inability to duplicate sizes, loss of production, and a waste of power.

Two-thirds of my visits to instruct operators are to teach them how to use their wheel in order to obtain the greatest production with the least wheel cost, and at the same time produce accurate work. This is rather difficult because the right wheels for certain work in one shop are too soft or too hard to be of use on the same work in another shop.

Piston pins in one automobile factory are finish ground on a 6" x 32" Norton Machine with a 24 O wheel, 800 per day. In another factory these same pins are ground with a 24 K, six hundred per day. Both customers are satisfied with the wheels they are using. The first customer could not use a K wheel, while the second customer could not use an O wheel; and no one can convince the first customer that he should use a K wheel, or any other wheel but a 24 O.

2. "What is the difference between glazing and filling?"

Filling takes place when wheels are too hard and revolve at too slow a speed.

Glazing takes place when wheels are too hard and revolve at too fast a speed.

3. "What are some of the indications that a wheel in use is hard?"

If the machine requires great power to run it (greater than recommended by its maker), the machine, in all probability is using too hard a wheel. Other indications are:—the necessity for frequent adjustment of wheel spindle boxes; the surface produced may have feed lines, chatter marks, or is of a bluish gray surface when it should be a light gray; automatic cross feed refusing to duplicate sizes quickly, requiring a long time for the cut to disappear after the wheel feed index shows that the work is at the proper diameter; requiring frequent dressing.

4. "If the grinding wheel appears hard, and another wheel cannot be obtained, how can the wheel be better adapted to the work, and why?"

If the speed of a hard wheel is too fast, I should first cut it down to its proper

surface speed. I should also use a sharper diamond to dress the wheel, because a sharp diamond leaves the surface of the wheel with more clearance, and the surface would cut like a softer wheel for a greater length of time. I should also increase the surface speed of work, because by increasing the surface speed of work, the grain depth of cut will be increased, and the glazing surface caused by hard bond will wear away, and the surface act like a softer wheel.

5. "If the wheel appears soft, so that it wears away rapidly, what change would you make in the work speed to improve the working of the wheel?"

In connection with this subject, I will relate an experience of two years ago.

A customer was using a 10" x 50" Norton machine, grinding work placed on arbors. These pieces were $3\frac{3}{4}$ " diameter, by 1 1-8" face, and ten (10) were ground at one time on the arbors. Using a 3860 L, 18" x 2" x 5" wheel, our machine produced 690 pieces in $9\frac{1}{2}$ hours. As the wheel wore away, the production dropped less and less, until when the wheel was 15" diameter, the production was only six hundred pieces in $9\frac{1}{2}$ hours. The speed of work, with an 18" diameter wheel, was seventy-five feet per minute. When the wheel wore to 15" diameter, with this same 75 feet per minute of work speed, the wheel appeared softer; but in reality it was no softer than it had been at 18" diameter.

By decreasing the work speed to 50 feet per minute and increasing the depth of cut .00050", we overcome the difficulty and proved that the wheel was the same grade at 15" diameter as it was at 18" diameter, and the operator's production the next day, with the same wheel, was nine hundred and fifty pieces.

Thus it is seen that by decreasing the work speed, thus diminishing the grain depth of cut and increasing the radial depth of cut, the production was carried up from six hundred pieces to nine hundred and fifty pieces per day without undue wear on the wheel.



Grinding Two or More Diameters at One Cut With a Single Wheel

By JOHN C. SPENCE

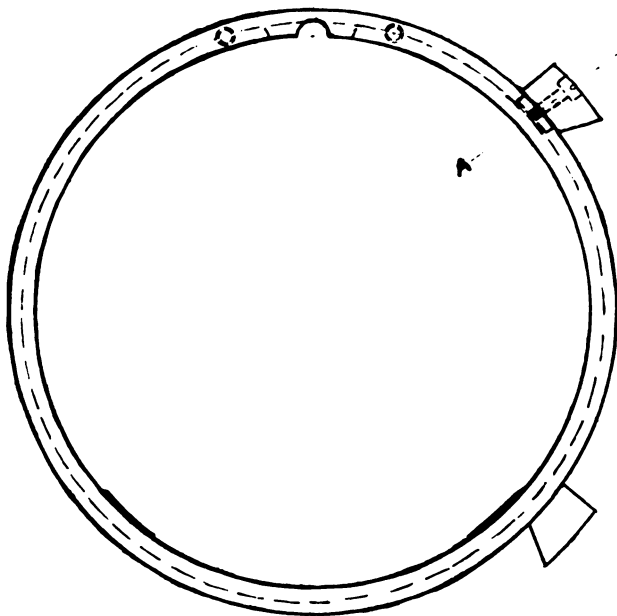
Several years ago, the Singer Sewing Machine Co. of Elizabeth, N. J., succeeded in grinding small shafts of several diameters with one "straight-in" cut of the wheel.

About six years ago a simple device was made at the Norton Grinding Co. to enable the users of Norton Grinding machines to either true two or more diameters on the same wheel or to bring a plain-faced wheel to two or more different diameter positions, without the usual trouble of manipulating the index stop. In addition, the chance of spoiling the piece is also reduced.

When the sum of the lengths of all the

diameter is correct, all others are also correct. If the difference in size between the various diameters is very small, it does not pay to turn the several diameters, but simply to produce a straight piece and depend on the wheel to produce the slight differences. This imposes a little more work on some parts of the wheel and the truing will be more frequent, but they are usually cheaper than the producing of these same slight differences by other means.

When the various portions of a shaft are of such lengths that they are longer than the wheel is wide, and the work must traverse, then this scheme is employed to



*Section on "A-B"
Showing How Block
is fastened.*

**Pencil Sketch of Attachment
to Wheel Feed
Index**

diameters to be ground is less than the width of the wheel the machine can carry, it is most economical to true several diameters on the wheel face. The work is then ground just as any ordinary wide cut piece would be ground. When one

allow the wheel to shift from one diameter to another, with accuracy, but using only one stop.

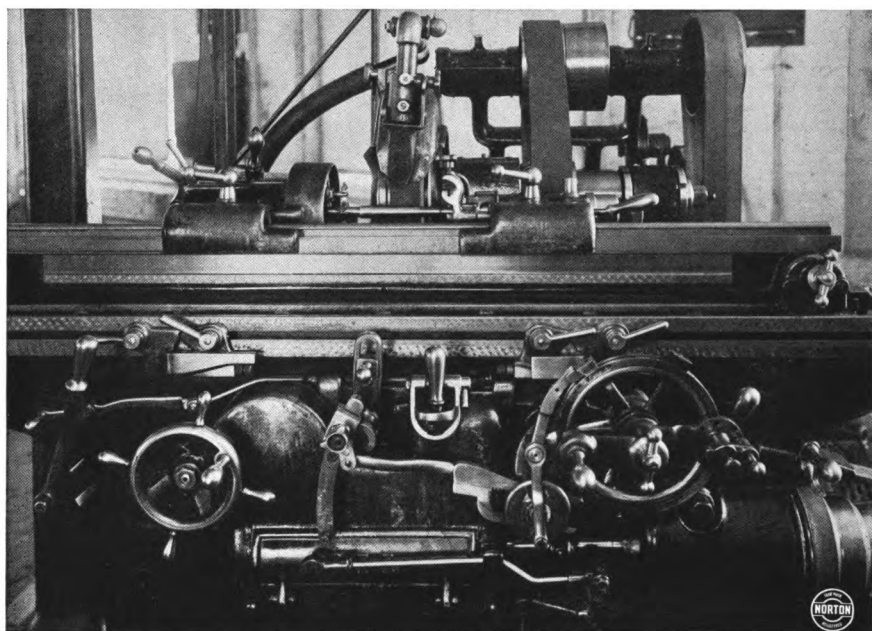
The means of attaining this will be better understood by referring to the illustrations.



Fig. 3 shows the device attached to the regular index crank of a Norton machine. It consists of a metal ring in which a dove-tailed slot has been turned, as shown in the cross-sectioned sketch in Fig. 1. By means of the small screws and wedges, any

the ring, the second block will come in contact with the stop arm and the wheel will have finished the smaller diameter seen in the picture.

If, on the other hand, it had been desired to produce two different diam-



View of Wheel Feed Index in Operation

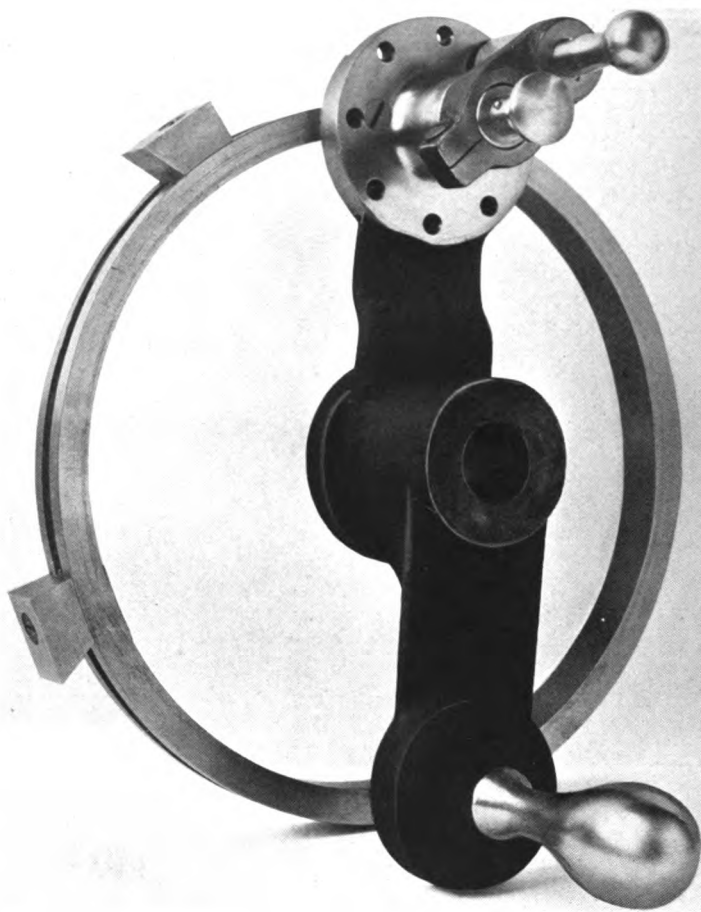
desired number of blocks can be fastened to the periphery of this ring.

These blocks can be adjusted around the ring so as to be in exactly the proper place to stop the wheel in any given diameter position. By numbering or lettering these blocks and correspondingly numbering or lettering a working drawing, the operator knows just how far in to bring the wheel for the various diameters.

Such a device is shown in working position in Fig. 2. The wheel has already finished the large diameter of the shaft that is in the machine and it will be noted the first block on the ring is against the stop arm. Now, by still further turning

eters on a given wheel, the procedure would have been different.

First, the wheel would have been trued straight across the face with the first block against the stop arm. Then the ring would have been turned until the second block rested against the stop arm. The wheel has, therefore, been advanced towards the diamond by some certain predetermined amount. If, now, the diamond is traversed along the wheel face for the required distance, a portion of the wheel will be *smaller* in diameter than the balance of the same wheel. Therefore, if the wheel is brought "straight-in" against the work it will produce two diameters,



Wheel Feed Index Crank with Device Attached

and the *larger* of these will be made by that part of the wheel that is the *smaller*.

Practically the only limiting factors to the use of extremely wide wheels are (a) the difficulties attending the production of wide wheels; and (b) the limit of rigidity and wearing qualities of the wheel spindle and work supports. The progress towards

the overcoming of these hindrances has been so great, in the past few years, that it is not mere guessing to say that we will see shafts of a foot or more in length having several different diameters ground in one single cut in the same time it now takes to grind any one of the diameters.

GRITS and GRINDS

WELCOME

NORTON
COMPANY

NORTON
COMPANY

SPECIAL CONVENTION EDITION

APRIL 20-24, 1914

**NATIONAL METAL TRADES ASSOCIATION
NATIONAL MACHINE TOOL BUILDERS ASSOCIATION**

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Grits and Grinds

Vol. V

April, 1914

No. 12

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Interesting features, facts and statistics about Norton Company and Norton Grinding Company plants—reprinted from the special convention edition of "Grits and Grinds" published in connection with the conventions of the National Metal Trades Association and National Machine Tool Builders Asso., held in Worcester, week of April 20

Norton Company

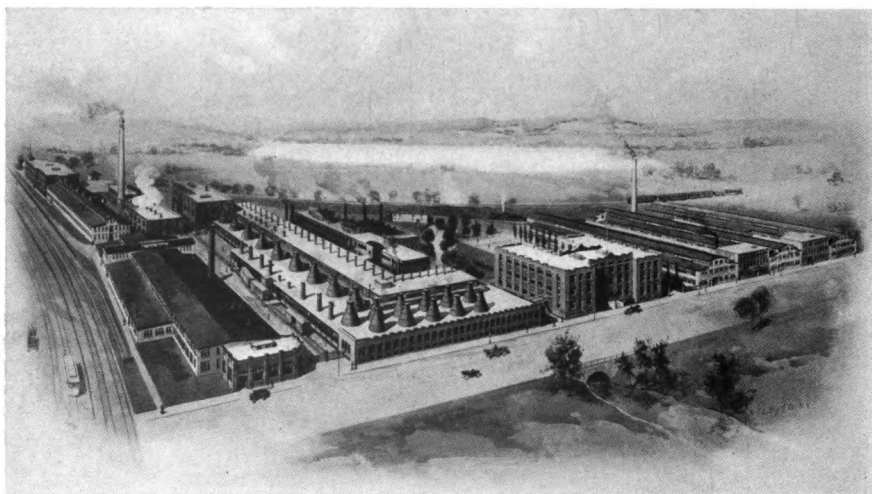
Organized 1885 as Norton Emery Wheel Company.

Name changed to Norton Company in 1906.

Present Officers and Directors: George I. Alden, President; Charles L. Allen, Treasurer and General Manager; Aldus C. Higgins, Secretary and General Counsel; John Jeppson, Superintendent; George N. Jeppson, Works Manager; R. Sanford Riley.

First vitrified emery wheel made in 1873 in pottery of F. B. Norton, Worcester.

First wheels manufactured commercially in 1879.



Norton Company and Norton Grinding Company



First Norton Floor and Bench Type Grinding Wheel Stands introduced in 1892.

India Oilstones first produced in 1897.

Alundum first used commercially in Norton Grinding Wheels in 1901.

Niagara Falls abrasive plant established in 1901.

In 1906 Alundum superseded emery and corundum in the manufacture of Norton Wheels.

Ground broken for Wesseling, Germany, plant—Deutsche Norton Gesellschaft, M.B.H.—in 1909.

Crystolon plant at Chippawa, Ont., Can., erected in 1910.

Norton Refractories and Laboratory Ware first produced commercially in 1910.

Electrically Cintered Magnesite for the lining of electric steel furnaces introduced in 1914.

1885—Floor space, 560 sq. ft.; 1914—455,000 sq. ft.

Horsepower used, 15; 1914—1,566.

Number of employees, 13; 1914—1,100.

Number of kilns, 2; 1914—35.

Land occupied by Norton Company and Norton Grinding Company plants—7.28 acres.

Over 23,000,000 lbs. of Alundum and Crystolon were used in the manufacture of Norton products in 1913.

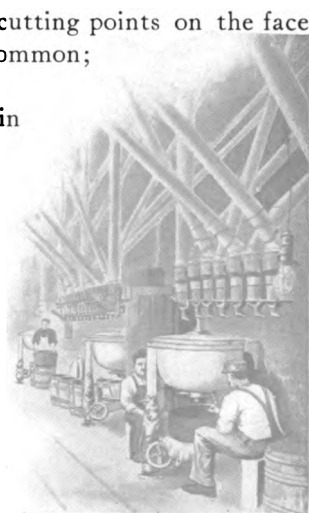
Wheels made in sizes varying from $\frac{1}{8}$ inch to 6 feet in diameter and from 1-64 inch to 20 inches in thickness.

In ordinary grinding practice, 400,000,000 cutting points on the face of the grinding wheel at work per minute is common; over 800,000,000 is not unusual.

Over 1,000,000 wheels are carried in stock in more than 40,000 varieties of grain, grade and size, and over 400 special shapes.

Stock rooms have over $1\frac{3}{4}$ miles of aisles and over $9\frac{1}{2}$ miles of racks.

If it were possible to build a pyramid of the wheels in stock with one 60 inches in diameter by six inches thick as a base, grading down through the stock sizes, and topping the pile with one 2 5-12 inches in diameter by 1-32 inch thick, the man placing the last one would need a ladder eight miles long to accomplish the feat.





Research Laboratories established at Worcester plant in 1899.

Electro-Chemical Research Laboratory established at Niagara Falls in 1904.

Norton Hospital opened in 1911. Number of cases of sickness treated in 1913—1664; of accidents—537; number of physical examinations since founding of hospital—2,186.

Scientific American gold medal for devices for protection of life and limb awarded Norton Company in 1911.

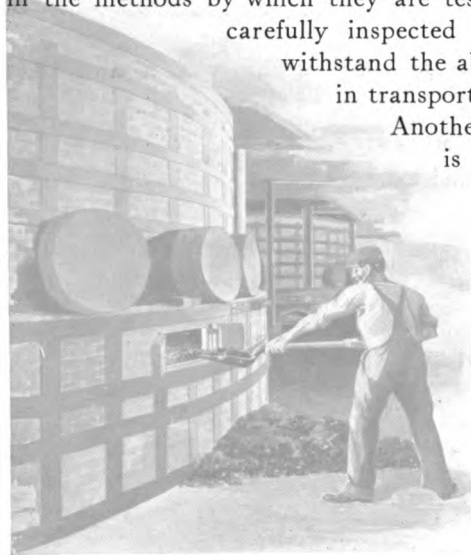
Safety Engineering Department established in 1913.

If you accept the invitation to visit Norton Company and Norton Grinding Company you will receive a hearty welcome. Your guide will gladly show you the particular things or operations in which you are especially interested.

Perhaps you would like to see how Alundum and Crystolon are crushed and then graded to size through screens of silk, or how the abrasive and bonds are accurately weighed and mixed to produce wheels of desired grain and grade.

Firing (baking in kilns), truing and bushing, grading—all of these operations are of interest to a visitor.

You may have a desire to know how wheels are graded—that is, how the grade of hardness is determined; or, you may find special interest in the methods by which they are tested for safety; or, how they are carefully inspected before shipment and packed to withstand the abuses to which they are subjected in transportation.



Another interesting feature of the plant is the extensive stock rooms where wheels in many thousands of sizes and combinations are carried for the accommodation of customers.

The extent to which research work is necessary for the development of grinding wheels is rarely understood, and our well equipped Research Laboratories—Analytical, Organic, Ceramic and Mechanical, will arouse your interest.



The products of Norton Company are: Grinding Wheels and a great variety of sharpening stones made of both Alundum and Crystolon; Norton Refractories—Alundum and Crystolon; Glass Cutting Wheels; Scythe Stones; Rubbing Bricks and Stones; Valve Grinding Compound; a line of grinding machinery of the simpler type such as Bench and Floor type of Grinding Wheel Stands, Saw Gummets and such accessories as Protection Hoods, Cylinder Chucks, Bushing Chucks, etc.

Norton Grinding Company

Incorporated 1900.

Present Officers and Directors: George I. Alden, President and General Manager; Charles L. Allen, Treasurer; Aldus C. Higgins, Secretary and General Counsel; John Jeppson, George N. Jeppson, R. Sanford Riley.

Floor space, 143,000 sq. ft.

Three hundred and twenty-five K. W. electric power employed.

Number of employees, 475.

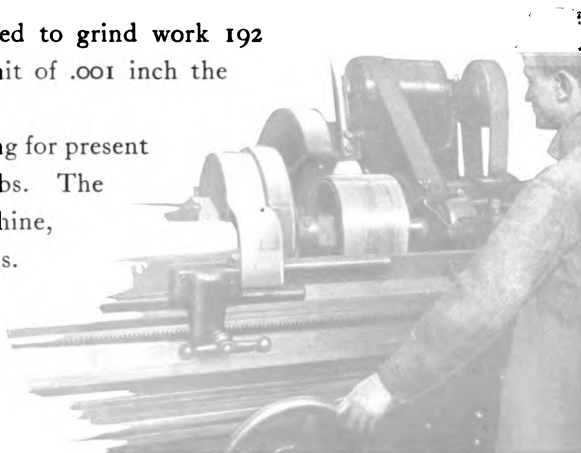
First Norton cylindrical grinding machine shipped in 1901 to R. Hoe & Co., N. Y.

Thirty-five kinds of cylindrical grinding machines built and 180 modifications of these.

Machines constructed to grind work 192 inches long within a limit of .001 inch the entire length.

Largest single casting for present designs weighs 15,951 lbs. The entire weight of this machine, 26" x 144", is 36,261 lbs.

The largest Norton roll grinding machine weighs over 50 tons and grinds work 54 inches by 252 inches.





The spindle and drive gear weigh one ton and the wheel slide $2\frac{1}{2}$ tons. Larger machines than this are already designed and only await the demand to be constructed.

Over 3,000 Norton cylindrical grinding machines are in use.

One man and helper operate six Norton automatic cylindrical grinding machines for chuck work, producing 810 pieces per hour, where on a hand-fed machine one operator formerly ground 40 pieces per hour.

Notable among the other types of grinding machines manufactured by Norton Grinding Company are car wheel grinding, car axle grinding and universal tool and cutter grinding machines.

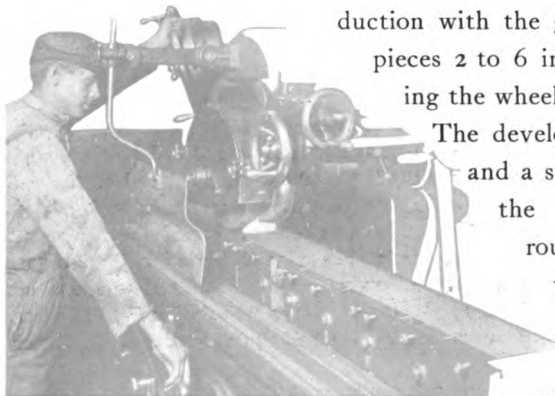
Norton running balance indicating machine is a practical, simple machine for indicating errors in running balance, by which an ordinary workman can secure dynamic balance without the use of mathematics.

Norton pendulameter is a device developed for magnifying errors of parallelism in the ways of such machines as planers and grinding machines. The pendulameter magnifies such errors 500 times, enabling machine builders to obtain a high degree of accuracy.

Among the notable achievements of Norton Grinding Company are these:

The construction of the first grinding machine which would remove as much as 3 cubic inches per minute of steel or chilled iron.

The development of the method of obtaining a high rate of production with the grinding wheel by grinding pieces 2 to 6 inches long without traversing the wheel.



The development of rigid steady rests and a system of grinding to utilize the discovery that perfectly round or perfectly straight work could be ground on rigid steady rests regardless of contour of work before grinding.



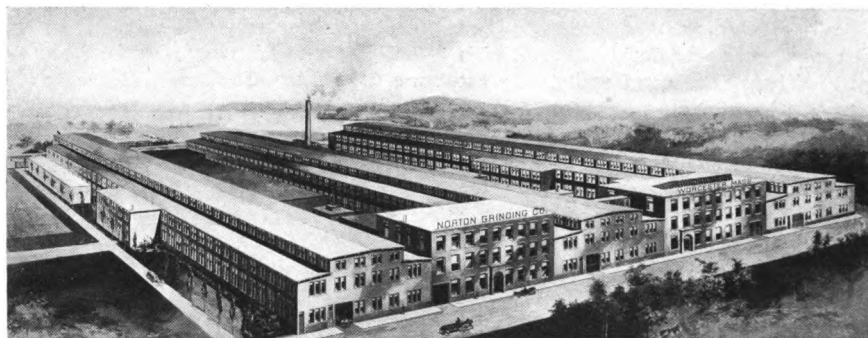
The building of the first machine for forming cams from the solid stock without milling or other tool work.

The building of the first machine to grind the entire pin and fillet on crankshafts simultaneously, with a wheel face the entire length of the pin.

The development of the first machine which would grind perfectly flat surfaces. This is accomplished in a machine using a wheel as wide as the work and without cross feeding, as distinct from the method depending upon a narrow wheel slowly feeding across the surface.

A well equipped grinding department is in operation where commercial grinding work is done. Large quantities of crankshafts have been ground for automobile concerns in the past few years, and it is probably safe to say that at some time or other Norton Grinding Company has made master cams for nearly every automobile company in the United States, and many of the foreign concerns as well.

A force of some 25 men are constantly busy in the engineering department designing and developing special fixtures, attachments and devices for grinding machines, master and model cams for the grinding of cam shafts for automobiles and gas engines, and in similar activities. Although the majority of the types of machines manufactured are in operation at this plant, there are, of course, a few which cannot be seen at this time.



Norton Grinding Company



Norton "Safety First" Association

A "Safety First" Association was formally organized among the officials and workmen of Norton Company and Norton Grinding Company on March 20th. At the organization meeting there were present all the foremen and assistant foremen of both companies, also one workman from each department. After a complete explanation and some discussion of the plans for this association, as outlined below, the meeting proceeded to elect officers. Mr. C. L. Allen, general manager of the Norton Company, was elected president, and Mr. C. H. Norton, chief engineer of the Norton Grinding Company, vice-president. Following this, a constitution was adopted and the following standing committees appointed:—Membership, Social, Reward, and Nomination. All of those present signed the charter roll of the association, and the representation of the workmen present will constitute the first group of department safety inspectors.

The beginning of safety work in the factory of Norton Company was in March, 1909, when the first safety committee was organized. This committee was composed of five members,—four being heads of departments, and one a member of the engineering department. This committee has made monthly inspections of the plant, and subsequent recommendations. The results being that practically all dangerous places in the plant have been guarded and it is certain that a great many accidents have been prevented by their work. That the work of the Safety Committee has been thorough is proven by the fact that on investigation the causes of all accidents reported to Norton hospital, it is indeed very seldom that the cause of an accident can now be attributed to the lack of a mechanical safeguard. The safety committees of the Norton Company and the Norton Grinding Company will continue this work as they have in the years past, and will enter

into the "Safety First" Association, being designated by the constitution as the permanent executive committee.

A study of the accidents which were happening in the plants of both companies showed that they were almost always due either to inevitable risks or to carelessness. Further study showed that if the accidents caused by carelessness could be eliminated those remaining would be almost insignificant in number.

With this in mind the safety committees of Norton Company and Norton Grinding Company were called together for the purpose of organizing a safety educational campaign. After several meetings the following plan of procedure was recommended and has been carried out.

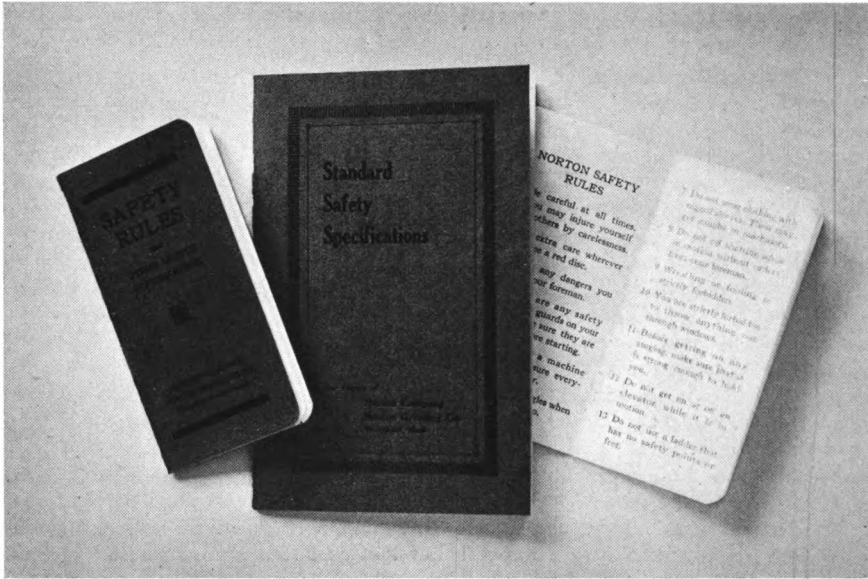
First: to establish a standard for all mechanical safeguards; a book of standard safety specifications was given to all foremen, draftsmen, inspectors and others who have occasion to order machinery of any kind.

Second: a book of safety rules for workmen was drawn up and each man who learns the rules to the satisfaction of the committee is made a member of the Norton "Safety First" Association, and is given an attractive button as an incentive. This society holds social meetings at which discussion of safety topics forms part of the programme, to which only members wearing buttons are admitted.

Third: a set of safety rules for foremen was adopted, which was issued to each foreman and assistants.

Fourth: to assist the foremen in enforcing the safety rules, a safety inspector was appointed in each department, whose duty it is to report any one whom he sees violating the safety rules or any dangerous condition which he observes in his department. These inspectors wear a special button as a badge of authority and an official notice of their appointment is posted in each department.

To introduce the subject to the men,



Safety Literature Issued to Foremen and Employees

the words, "Safety First" were printed in large letters on the pay envelopes. This got the men to asking what these words meant. After two issues of such pay envelopes, large placards—printed in three languages—were posted in various parts of the works, which gave a short explanation of "Safety First." An announcement of the proposed organization

was also published in the monthly "Health and Safety" bulletin, issued by the Health and Sanitation Department.

No attempt has been made to coerce the men into joining, but the response of the workmen to the invitation has been prompt and many from all departments have already qualified as members.

Truing Grinding Wheels for Rapid and Accurate Grinding

By CHARLES H. NORTON

When considering the question of truing grinding wheels one should not become confused with dressing grinding wheels, because the dressing of a grinding wheel is altogether a different matter. Dressing is done to rough up a grinding wheel as well as to true off the high points and make the wheel approximately concentric, but truing a wheel as understood by users of wheels for grinding cylindrical

and accurate surface work is not roughing the wheel, but making it very accurate as to concentricity and surface. Even this class of truing may be divided again into two kinds, one for sharpening the wheel as well as for making it perfectly true, and the other for dulling the wheel while making it perfectly true, that is, putting a very smooth surface upon the wheel.

Accurate truing, which is not dressing,



is accomplished with a diamond, and this diamond should always be held in a fixed tool post, never in the hand. There should always be a liberal supply of lubricant or water flowing on the diamond while the truing is being done. Allowing the water to be on the diamond part of the time and off part of the time is very bad for the diamond, and also it prevents the operator from securing a perfectly smooth wheel face.

With modern cylindrical grinding and modern surface grinding a relatively coarse wheel is used for removing the greater part of the material that is to be removed, a wheel so coarse that its grain will not allow, when cutting freely, of a finish fine enough. We, therefore, after removing the material, require just before finishing, to true the face of the wheel with a diamond that does not have a very sharp point, but preferably has a small rounded, or perhaps considerably rounded, point. Then by very slow passing of the diamond over the face of the wheel when the diamond is held in a fixed tool post, we create a surface on the wheel which is smooth, and at the same time perfectly true. This surface is a temporary one on this otherwise coarse wheel, but by careful application of the wheel to the work, not to disturb its surface, we secure a finish on the work. In other words, the quality of the finish on the work depends upon the quality of the surface on the wheel.

When a second piece is to be ground roughly a relatively deep cut is taken by the wheel; this smooth surface disappears, and we have the coarse wheel in action again.

Many times it is necessary to true a grinding wheel perfectly because chatters have occurred in the work, due to uneven wear of the wheel or vibration of the work itself. Careful retrueing and smoothing the face will secure accurate ground work always, if this truing and smoothing is done carefully.

Some people still use for cylindrical grinding, wheels that are fine and dense.

These people require a diamond with a sharp point in order that they may somewhat rough up the surface of the otherwise too smooth a wheel. In this case, as in the other, water must flow on the diamond all of the time when it is cutting, but instead of very slow passes across the wheel, a little more rapid passes are required for this class of truing, but in no case for accurate work should one presume to use a so-called wheel dresser. It is impossible by its use to do cylindrical grinding that is any way accurate. For accurate cylindrical work the most profitable wheel to use is one that requires frequent truing. It is a mistaken idea, that many have, that truing of a wheel is lost time and expensive.

In other forms of grinding of a less accurate nature, the so-called wheel dresser is used to advantage. Even there it should be held in some kind of a guide or tool post to secure as true a wheel as possible, although the cutters of the wheel dresser are roughing the surface to give the wheel a more rapid cutting surface. It would probably be more profitable if a wheel soft enough to keep free cutting without the use of a dresser could be used, if it were not for the fact that many workmen become careless and break into a soft wheel, causing it to run out of true quickly and to be wasted. Therefore, a somewhat harder wheel is used, requiring in some cases dressing to increase the production.

The popular idea of a diamond for truing a wheel is that it should always have a sharp corner in order to cut sharply on the wheel, and make the wheel face perfectly sharp. This idea is so prevalent that it has been suggested by one writer that the diamond be revolved while truing the wheel. After thirty years' experience with grinding, the writer believes that the most useful diamond is the one that does not have a sharp corner, and the most useful wheel is one that is sufficiently soft and coarse that when trued it is made more dull than if not trued, for the reasons given above.



Abstracts from Current Articles Pertaining to Grinding

Descriptive Index or Synopsis of Articles Pertaining to the Grinding Industry that Have Appeared in Recent Issues of Technical and Trade Publications

Hob and Cutter Grinder by The Lees-Bradner Co., Cleveland, Ohio, designed especially for sharpening hobs and radially relieved cutters. *Canadian Machinery*, Jan. 1st, 1914, page 13.

The Stockbridge Machine Co., Worcester, Mass., has brought out a portable grinding machine for jointer-knives, without removing them from position. *Iron Age*, Jan. 26th, 1914, page 553; *American Machinist*, Mar. 5th, 1914, page 437; *Machinery*, March, 1914, page 608.

Planer type surface grinder by Newton Machine Works, Inc., Philadelphia, Pa., for grinding locomotive radius links, tongue pins, armor plate, etc. The abrasive wheel remains in a fixed position while the work held in pneumatic chucks is traversed on the table. The wheel is adjusted for the full depth of cut and full width in one operation. *Machinery*, March, 1914, page 613.

Plain grinding machine by Modern Tool Co., Erie, Pa. Particular attention has been paid to features which will lessen the cost of production of work which requires grinding. *Machinery*, March, 1914, page 613.

Fixture for grinding parallels on Brown & Sharpe grinder, No. 13, by Clayton Dane, Pottstown, Pa. *Machinery*, March, 1914, page 587.

An article on "Glasses and the Grinder," as described and illustrated by E. A. Thanton. *American Machinist*, March 19th, 1914, page 492.

The Webster & Perks Tool Company, Springfield, O., is building an electrically driven floor type grinder with the capacity for carrying a pair of 16 to 18" wheels with 3" face. Illustrated and described in *Foundry*, April, 1914, page 159. *American Machinist*, April 2, 1914, page 613.

A protective hood for hand wheel dressers is described and illustrated in an article in *American Machinist*, April 2, 1914, page 604.

The Van Dorn Electric Tool Company has brought out a line of alternating current machines equipped with one-third horsepower motors. This line consists of five types, a bench machine, a tool post machine, an aerial machine with end and body handles and an aerial machine with extensions. *Iron Age*, April 2, 1914, page 892.

"Work Speeds in Grinding" is discussed by James O. Smith, Providence, R. I., in *Machinery*, April, 1914, page 684.

The "Dumore" portable electric grinder is a product of the Wisconsin Electric Co., Racine, Wis. Several illustrations of typical operations performed with this grinder and descriptive matter appear in *Machinery*, April, 1914, pages 711-712.

A large rotary magnetic chuck for use on a special grinding machine has just been completed by O. S. Walker & Co., Worcester, Mass. It is 70" in diameter and weighs 2400 pounds. *Machinery*, April, 1914, page 715.

The Standard Electric Tool Co., Cincinnati, O., is now making a line of portable electric tool post grinders equipped with universal motors designed to operate on either direct current or alternating current of 0 to 60 cycles. *Machinery*, April, 1914, page 713; *Iron Age*, March 26, 1914, page 783.

Article on "Promoting Safety in Grinding Wheel Work"—how steel hoods can be used to advantage on grinding machines, with suggestions for other safety measures—is an article in *The Foundry*, April, 1914, pages 129-131.



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